# Taxes and Capital Structure: Understanding Firms' Savings[*]

Roc Armenter
Federal Reserve Bank of Philadelphia

Viktoria Hnatkovska
University of British Columbia

August 19, 2016

## Abstract

The U.S. non-financial corporate sector became a net lender to the rest of the economy in the early 2000s, with close to half of all publicly-traded firms holding financial assets in excess of their debt liabilities. We develop a simple dynamic model of debt and equity financing where firms strive to accumulate financial assets even though debt is fiscally advantageous relative to equity. Moreover, firms find it optimal to fund additional financial asset holdings through equity revenues. The

---

[*] We thank Paul Beaudry, Mitch Berlin, Fabio Braggion, Michael Devereux, Burcu Eyigüngör, Dalida Kadyrzhanova, Amartya Lahiri, Ellen McGrattan and the audiences at the University of British Columbia, Wharton School, FRB Philadelphia, Sauder School, Banco de España, Bank of Canada, Philadelphia Fed-NBER conference "Macroeconomics across time and space," SCE at San Francisco, the NBER Summer Institute (EFACR, EFEL), Berkeley, FRB San Francisco, FRB Minneapolis, Fordham University, Georgetown University, Tilburg University and the Federal Reserve Board for their comments and suggestions. This research was supported by the Social Sciences and Humanities Research Council of Canada, grant number 12R20471. The views expressed here do not necessarily reflect the views of the Federal Reserve Bank of Philadelphia or the Federal Reserve System. This paper is available free of charge at http://www.philadelphiafed.org/research-and-data/publications/working-papers/ This paper previously circulated under the title "The Macroeconomics of Firms' Savings".

calibrated model matches well the distribution of public firms' balance sheets during the 2000s and correctly predicts which firms are net savers.

**Keywords:** Corporate savings, debt, equity, dividend taxation.

# 1 Introduction

Since the early 2000s the U.S. non-financial corporate sector has emerged as a net lender to the rest of the economy. The sector's net financial asset (NFA) position, defined as the difference between financial assets and debt liabilities, has averaged over 3 percent of the value of its tangible assets (capital henceforth) for the period 2000-2007. Net savings are also widespread at the firm level. More than 40 percent of publicly-traded firms in the U.S. averaged a positive NFA position for the period, with some firms holding net financial assets in excess of their tangible assets.[1]

The magnitude and prevalence of firms' savings are especially surprising since debt holds a substantial fiscal advantage over equity, as firms can expense interest payments from their taxable corporate income while dividends and capital gains are taxed. Any favorable tax treatment of debt breaks the well-known Miller-Modigliani irrelevance result, implying that firms should be as leveraged as possible and minimize their reliance on equity to finance investment. The data clearly suggest the opposite pattern as firms with a positive NFA position—that is, more financial assets than debt—must have equity in excess of their tangible assets.

Understanding the size and distribution of corporate savings across firms is important for several reasons. Foremost, internal funds allow firms to insulate themselves from the vagaries of financial markets. Thus any attempt to quantify the importance of financial frictions or shocks must account for the observed financial positions of firms, including

---

[1] The data were quite different in the 1970s and 1980s when the U.S. corporate sector was a net debtor, borrowing as much as 20 percent of its capital. The increase in NFA from 1970 to 2000 echoes a dramatic rise in cash holdings by U.S. firms (see Bates et al. (2009), among others) and a decrease the firms' long-term liabilities. Section 2 and Appendix A contains data definitions and sources.

NFA. More broadly, an understanding of the firms' balance sheets is required to pin down the firms' cost of capital and its determinants. This becomes indispensable if one wishes to evaluate the effects of the various capital-income taxes—dividend, capital gains, and corporate tax rates—on the cost of capital and the capital-to-output ratio.

In this paper we argue that the fiscal advantage of debt can actually drive firms to accumulate financial assets in a fully dynamic, stochastic setting. Consider a risk-neutral entrepreneur, subject only to statutory tax rates and a debt limit. In order to minimize the fiscal burden, the entrepreneur will seek to finance investment exclusively through debt, only resorting to equity when reaching the firm's debt limit. This introduces differences in the cost of capital across firms with different internal funds, or net worth. A firm with low net worth must resort to equity to finance most of its investment, and incur in a high cost of capital in doing so, while a firm with available internal funds can use these or rely exclusively on debt, reducing its cost of capital. Quite naturally, thus, the firm's value becomes concave as a function of its net worth solely on the basis of the differential tax treatment and the debt limit. The concavity of the firm's value gives rise to a "precautionary motive"—akin to the behavior of a risk-averse household—to accumulate financial assets as the entrepreneur seeks to minimize the firm's future reliance on equity issuance.

We formalize and evaluate our argument with a simple model of heterogeneous firms. By design, the capital structure of a firm is irrelevant in our model if debt and equity distributions are taxed equally.[2] Risk-neutral entrepreneurs operate a decreasing-returns-to-scale technology. Capital is determined by the firm's investment in the previous period, which can be financed by internal funds, debt or equity.[3] Firms face a non-default

---

[2] We thus implicitly take a narrow view of the relative costs of equity and debt in order to focus on our mechanism and the role of taxes. We recognize that there are other important factors influencing the relative costs and benefits of equity, such as floatation costs, agency considerations, and deadweight loses associated with liquidation. See Frank and Goyal (2008) and Tirole (2006) for an overview of empirical and theoretical work.

[3] It is crucial that we allow for multiple sources of financing given our focus. See Gamba and Triantis (2008) and Boileau and Moyen (2009), inter alia.

constraint on their fixed-income liabilities.[4] We assume that equity distributions are positively correlated with the firm's cash flow and capital. Households choose how much to consume, save and work, providing the remaining general-equilibrium conditions. Firms are heterogeneous regarding their net worth and productivity, which evolves stochastically.

In our model, firms find it optimal to fund additional financial asset holdings with equity revenues, despite the latter's higher cost. Using equity to fund acquisitions of financial assets increases the internal funds available to the firm in the event of negative cash flow shocks, safeguarding the firm from having to issue *further* equity at later dates when the financing costs will compound. The intuition is as follows. A firm with low net worth has no choice but to issue equity to satisfy its financing needs due to the presence of a borrowing constraint. Since a large fraction of the cash flow is then committed to shareholders, the firm's net worth increases only very slowly, preventing the firm from reducing outstanding equity and resulting in high finance costs over a prolonged period. An additional dollar of internal funds allows a low-net worth firm to reduce equity reliance in the present *and future periods*, enabling the firm to build its net worth faster and escape being financially constrained. Since payouts are positively correlated with cash flows, preemptively issuing equity transfers internal funds from future states where the firm experiences positive shocks to those featuring negative shocks that deplete the firm's net worth. In other words, the firm values internal funds above the one-time cost of equity and is thus willing to raise equity revenues to build its financial asset holdings. Having accumulated internal funds the firm faces lower financing costs and can afford to invest more at later dates.

The model is calibrated to statutory tax rates for corporate earnings, interest income, dividends and capital gains. Given our focus on the firms' financial decisions, we specify a productivity process that incorporates the possibility of operational losses and investment opportunities, which are key determinants of the observed levels of financing needs in the

---

[4] Borrowing or debt constraints have received plenty of attention in the related literature: See Korajczyk and Levy (2003), Almeida et al. (2004), Bolton et al. (2011), Riddick and Whited (2009), among many others.

data.[5]

We show that our model provides an excellent match of the cross-firm distribution of NFA in the period 2000-2007. The model predicts a large share of firms with positive NFA: 42 percent in the model versus 44 percent in the data. It also matches the median, standard deviation and various percentiles of the distribution of ratio of NFA to capital. Importantly, the model generates the right tail of the NFA distribution found in the data. We also show that the model replicates key moments regarding investment, revenues, and cash flows. The model also matches the pattern of operational losses–the key driver of precautionary savings–across firms characteristics like revenues, capital, and age. We then take a closer look at net lending firms, that is, firms with positive NFA. In the model as in the data, firms with net savings have higher investment rates, more revenues and equity, and build up their equity faster.

We provide an additional model exercise by exploiting the time-variation in statutory dividend tax rates in the US, which illustrates the interplay between taxes, investment and financial positions. According to our calculations, reductions in dividend taxes in the 1980s and 1990s, up to the tax reform of 2003, reduced by half the fiscal cost of equity relative to debt.[6] Once the higher relative cost of equity in the 1970s is accounted for, our model predicts that firms rely less on equity to accumulate financial assets, and thus have lower NFA and equity positions. Quantitatively, we find the mean ratio of NFA to capital to be negative, at $-0.06$, compared to $-0.12$ in the data. The model is actually spot on regarding the median ratio of NFA to capital, $-0.16$ in the model versus $-0.17$ in the data, and quite close regarding the predicted share of firms with positive NFA: 32 percent in the model compared to 27 percent in the data. At the same time, the shift in the firms' financing from net borrowers to net lenders has only modest effects on investment.

---

[5] Standard specifications in the literature are calibrated to match revenue dynamics. These specifications do not generate enough finance demand because investment expansions are driven by positive productivity shocks, which also bring a cash flow windfall. It is thus too easy for the firms to self-finance. The role of negative cash flows is also emphasized in Gorbenko and Strebulaev (2010). In the data, the importance of shocks for firms' cash holdings has been documented by Opler et al. (1999), Bates et al. (2009) and, more recently, Bates et al. (2016).

[6] See also Poterba (2004) for further discussion on the taxation of corporate distributions.

The capital-to-output ratio predicted by the model for the 1970s is only a bit below — by 2.7 percent — the capital-to-output ratio in the 2000s. Indeed, one should see the large shift in balance sheet positions as evidence that the firms are able to substantially insulate the cost of capital from dividend taxes. We also investigate the effects of lower idiosyncratic risk faced by firms in the 1970s and show that the model's predictions for the cross-sectional distribution of NFA line up even closer to those observed in that decade.

Our work is closely related to several strands of the literature on both corporate finance and macroeconomics, as well as some work on the taxation of capital income.

The distinctive feature of our empirical work is the focus on the net financial asset positions of firms. Previous work had pointed out an increase in cash holdings by U.S. firms (see, for instance, Bates et al. (2009), Opler et al. (1999), Boileau and Moyen (2009), Sanchez and Yurdagul (2013) and others). Other work, though, had instead argued that U.S. corporations remain highly leveraged (see, for instance, Graham et al. (2012), Kalemli-Ozcan et al. (2012) and others).[7] We view our focus on NFA as complementary: While there is certainly much to be learned from the gross asset and liability positions of firms, looking at the NFA allows us to evaluate whether firms demand or supply savings to the rest of the economy and, arguably, NFA is the correct summary variable for the internal financial resources of the firm. We also note that the gross positions in asset and liabilities are practically irrelevant to establish the fiscal burden of equity relative to debt.

Any structural, dynamic model of corporate finance, including ours, owes a great debt to the seminal contributions by Gomes (2001) and Hennessy and Whited (2005, 2007), among others.[8] These models seek to explain many interesting firm-level findings in empirical corporate finance typically by including various adjustment or liquidation costs to match firm-level elasticities.[9]

---

[7] In our data set we find that both an increase in cash holdings and a decrease in liabilities—mainly long-term debt—are behind the rise in the NFA.

[8] Other closely related work include Whited (2006) and DeAngelo et al. (2011).

[9] For example, Hennessy and Whited (2005) propose a model that generates a negative relationship between leverage and lagged measures of cash-flows, debt hysteresis, and path-dependence in financing policy.

Our model emphasizes the close link between taxes and NFA accumulation due to a classic precautionary-savings motive.[10] Other work has argued for the importance of precautionary savings in firms, albeit due to different mechanisms. Boileau and Moyen (2009), for example, rely on convex costs of equity adjustments, an assumption also present in Hennessy and Whited (2007), inter alia. In their modeling of private-equity firms, Shourideh and Zetlin-Jones (2012) instead assume that ownership is concentrated at the hands of a risk-averse entrepreneur. The possibility of default with dead-weight costs can also create the necessary motive for precautionary savings.

There have been other hypothesis for the accumulation of financial assets recently put forward in structural models. Boileau and Moyen (2009) focus on the role of idiosyncratic risk and, in particular, of shocks driving the firms' liquidity needs. Similarly, Zhao (2015) argues that about two-thirds of the increase in corporate cash holdings can be accounted for by the increase in cash flow volatility. Karabarbounis and Neiman (2012) instead relate secular changes in the cost of investment to changes in corporate savings. Falato et al. (2013) propose a mechanism linking intangible assets to firm's cash holdings. Morellec et al. (2013) and Della Seta (2013) argue that in the presence of financing constraints, product market competition increases corporate cash holdings because it increases the risk that a firm will have to raise costly external finance. Ma et al. (2014) and Lyandres and Palazzo (2011) also focus on the role of competition for corporate cash holdings, but at the industry level, with the cost of innovation and R&D providing the link between the two. Finally, Gao (2015) argues that the switch to just-in-time inventory system has contributed to the rise in cash holdings of the US manufacturing firms. To the best of our knowledge, we are the first to highlight the key role that taxes—which can be directly observed—play in the firm's accumulation of financial assets. We see, though, our focus on taxes as complementary to other hypothesis.

Our work is also closely related to a growing literature studying the interaction of financing decisions with the real variables. Thus, Cooley and Quadrini (2001) use a model

---

[10] The motive has a long tradition in the field of household finance, see Carroll (1997) for a seminal contribution.

of industry dynamics to study the role of financial frictions and persistent productivity shocks for firm dynamics and their dependence on firms' characteristics, such as initial size and age. Cooley and Quadrini (2001), however, do not allow for capital accumulation and abstract from the role of taxes.[11] Jermann and Quadrini (2012) also formalize a model of debt and equity financing, but are interested in the cyclical properties of external finance and the effects of 'financial shocks'.[12] This interest is shared by Khan and Thomas (2013) who study the aggregate effects of financial shocks in a model with partial investment irreversibility, matching the distribution of investment and borrowing across firms. Unlike us, though, Khan and Thomas (2013) do not allow for equity financing. Uhlig and Fiore (2012) focus on the composition of corporate debt between bank finance and bond finance and its dynamics and effects on investment and output during the 2007–09 financial crisis. Relative to these studies our contribution is to focus on taxes and the cross-sectional distribution of firms' financial assets/debt and equity positions.

Our focus on the role of corporate and capital-income taxes has a long tradition in finance and macroeconomics. On the theoretical front, the literature has developed a number of insights for why taxes should matter for the corporate capital structure (see Modigliani and Miller (1963), Miller (1977), DeAngelo and Masulis (1980), and others). Recent empirical work has confirmed a statistical association between taxes and capital structure decisions of firms (Graham (1996, 1999, 2003), Fan et al. (2012), Desai et al. (2004), Faccio and Xu (2015), and others). In a closely related work, McGrattan and Prescott (2005) link tax and regulatory changes affecting the U.S. shareholder distributions to large secular movements in the value of U.S. corporations. Following the Jobs and Growth Tax Relief Reconciliation Act of 2003 there has also been a renewed interest in how dividend and capital gains taxes affect capital structure and investment. See, for example, Chetty and Saez (2005, 2006), Gourio and Miao (2010), and Gourio and Miao (2011).

---

[11] Other papers that feature endogenous dynamic financing and investment policies include Brennan and Schwartz (1984), Titman and Tsyplakov (2007), and Riddick and Whited (2009).

[12] Other studies that focus on the business cycle properties of external finance include Covas and Den Haan (2007), Bacchetta and Poilly (2014) and Choe et al. (1993) among others.

The paper is organized as follows. Section 2 documents the key facts regarding corporate NFA for the period 2000-2007. Section 3 describes the model setup and defines the industry equilibrium. We discuss how our model generates a simultaneous demand for equity and net savings in Section 4. We then turn to our quantitative analysis. Section 5 documents our calibration and Section 6 discusses the model fit and the key quantitative determinants of positive NFA. Section 7 documents and contrasts the model predictions for the high cost of equity environment of the 1970s. We conclude in Section 8. The Appendix contains a more detailed description of the data as well as several technical results regarding the model.

# 2 The US corporate sector as a net lender

In this section we document the key empirical regularities about the capital structure of the U.S. corporate sector. We present the evidence at both the aggregate and firm level. We start with the aggregate data, drawn from the Financial Accounts (formerly Flow of Funds accounts) of the United States. We focus on the non-farm, non-financial corporate business sector data on the levels of financial assets, tangible assets, liabilities and net worth during 2000-2007 period.[13]

We compute net financial assets (NFA) as the difference between financial assets and liabilities. A number of recent empirical studies have used cash holdings as a descriptor of firms' savings behavior (see, for instance, Bates et al. (2009), Opler et al. (1999), Boileau and Moyen (2009), Sanchez and Yurdagul (2013) and others) and showed that U.S. firms hold a substantial amount of cash on their balance sheets. Another large strand of literature focused on the liability side of the firms' balance sheets and showed that U.S. corporations remain highly leveraged (see, for instance, Graham et al. (2012), Kalemli-Ozcan et al. (2012) and others).

Our NFA measure provides a broader perspective on firms' savings behavior by includ-

---

[13] All series are converted into real terms using GDP deflator.

ing other types of financial assets in addition to cash. In all cases, we scale the variables by tangible assets, which provide a measure of the sector's capital stock. All variables are measured at market value.[14]

We find that the aggregate NFA to capital ratio in the 2000s is *positive*. This is in sharp contrast to the earlier periods: in the 1970s and 1980s the aggregate NFA to capital was relatively stable around -0.15, while in the 1990s it went through a run-up reaching 0.03 in the 2000s.[15] These developments highlight the transition of the U.S. corporate sector from a net debtor into a net creditor at the turn of the century.[16]

Which firms are net lenders? To answer this question we turn to disaggregated firm-level data from Compustat. We focus on U.S. firms only; we exclude technology and financial firms, as well as regulated utilities.[17] We also drop the firms whose capital is below 50,000 USD, those with negative equity, and zero sales.[18] This selection leaves us with a sample of 6535 firms in the 2000s. In line with the definitions used in the Financial Accounts data, we construct our measure of net financial assets in the Compustat database. Financial assets are obtained as the sum of cash and short-term investments, total other current assets, and account receivables. Liabilities are computed as the sum of current and long-term debt, accounts payable, and taxes payable. Our measure of tangible assets, or capital, includes firms' gross property, plant and equipment, investment and advances, intangible assets, and inventories.

---

[14] The Financial Accounts data set also contains the value of non-financial assets at historical cost. We find that using these variables does not change the trends in the ratios of NFA to capital but raises their (absolute) levels.

[15] Interestingly, during the 1950s and 1960s, the NFA to capital ratio in the Financial Accounts was above its level in the 1970s and 1980s. However, it remained negative throughout the period, making the qualitative switch of the NFA position in the 2000s unprecedented.

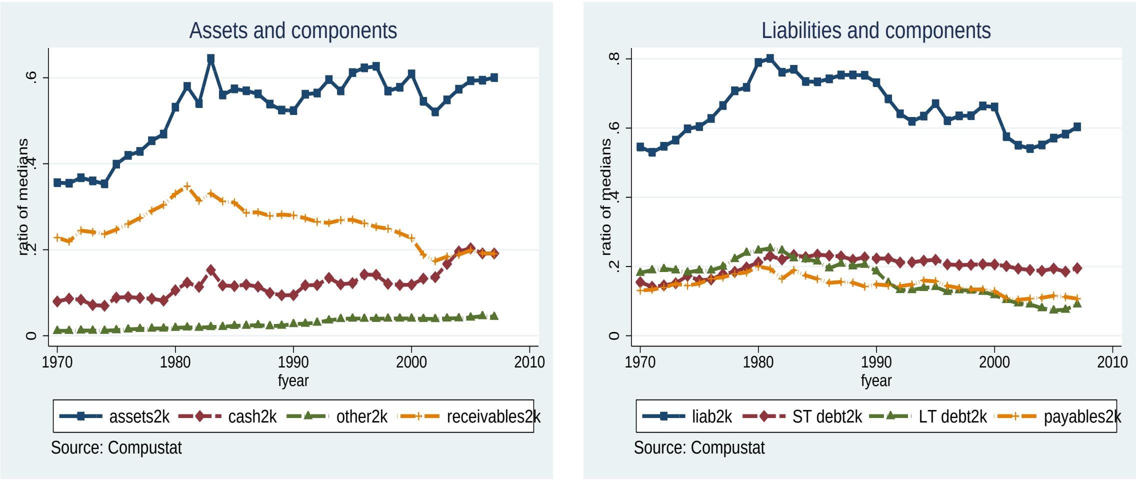
[16] Both aggregate asset and liability positions of the US corporate sector rose over the period, with assets rising faster than liabilities. Unfortunately, the Financial Accounts data provide only a few disaggregated components for both assets and liabilities, preventing us from an in-depth look into the factors behind the rise in aggregate NFA in the U.S. We provide a detailed account of these trends, their various decompositions and robustness checks using both aggregate and firm-level data in the online appendix available at http://faculty.arts.ubc.ca/vhnatkovska/research.htm.

[17] We exclude technology firms from our analysis due to a potentially serious mismeasurement of their capital stock, which is predominantly intangible.

[18] When computing statistics that are easily influenced by outliers we also eliminated the top and bottom 1 percent of observations in NFA and capital distributions.

In terms of the capital-output ratio, our Compustat sample comes very close to matching that ratio in the aggregate economy – the capital-output ratio in our sample is equal to 2 across all industries and is equal to 3 for the largest sector, manufacturing. In terms of overall size, non-financial Compustat firms employ about 36 percent of the aggregate U.S. labor force and hold 60 percent of the aggregate U.S. capital stock during the 2000s.[19]

The gross positions of firms in our dataset line up well with the data facts discussed in the literature. They are presented in Figure 1. Panel (a) of that figure shows median financial assets and their components such as cash and short-term investments, other assets, and account receivables, all as a ratio to median capital. Panel (b) presents median liabilities and their components such as short-term and long-term debt and account payables, also as ratios to median capital. From the figures it is easy to see that median gross assets are rising over time, while median gross liabilities are on a declining trend starting in the early 1980s. Most of the rise in assets is due to higher cash and equivalent holdings of U.S. firms. "Other assets" category has been going up as well, but at a much slower pace. Finally, account receivables have declined from about 28 percent of the median capital level in the 1970s to less than 20 percent in the 2000s.



(a) Assets

(b) Liabilities

Figure 1: Gross positions and their components

---

[19] See the online appendix for details.

On the liability side, long-term debt and account payables have both fallen over time, while short-term debt has shown a slight increase. Overall, these decompositions suggest a shift in firms' balance sheets away from long-term assets and liabilities toward their short-term counterparts, but with the share of account receivables and payables in the short-term assets and liabilities falling over time.

These findings clearly indicate that the rise in corporate savings was not driven entirely by cash and other short-term investments, and instead there have been substantial compositional changes in the gross financial assets and liabilities of the US corporate sector. We view our calculation of the NFA position—netting out the financial asset and debt liability positions—as an useful summary statistic of both the internal savings of the firms as well as the demand or supply of funds to the rest of the economy.[20]

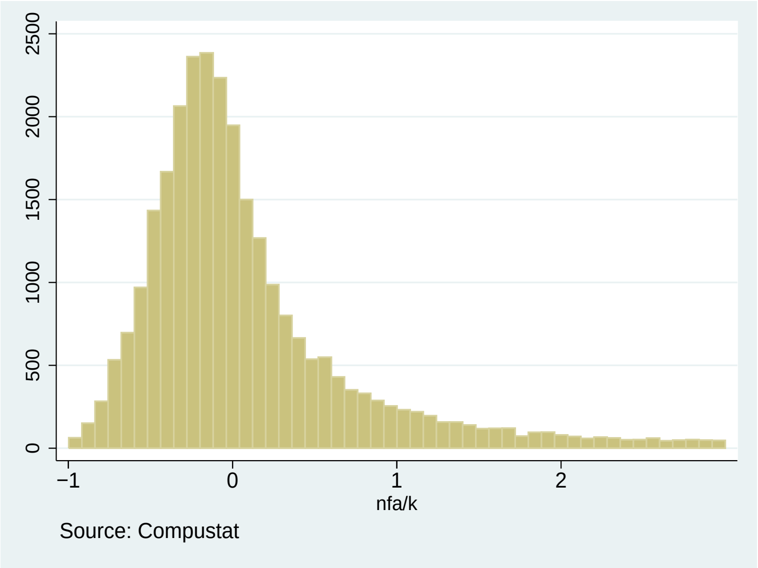
Turning to NFA, we find that mean NFA to capital ratio is positive for Compustat firms, very much like in the aggregate data, reaching about 12 percent in 2006-2007 and averaging 7 percent from year 2000. Like in the aggregate data, this ratio was negative at -10 percent during the 1970s.[21]

Figure 2 plots the distribution of the NFA to capital ratio across firms in the 2000s, while Table 1 reports summary statistics on this distribution. Several features stand out. First, the standard deviation is quite large, equal to 0.65. Second, the distribution of NFA to capital is skewed to the right: the top ten percent of firms in our data set have NFA positions exceeding 138 percent of their tangible assets. However, positive NFA are not confined to a small set of firms, driving the central moments: about 44 percent of all

---

[20] In deciding to focus on NFA in our empirical work, we were guided by the following considerations: (i) There is significant heterogeneity in firms' gross asset and liability positions, giving us fewer robust data facts to work with for gross position (see online appendix for further discussion); and (ii) for the main mechanisms that we propose in the paper there is no need to distinguish between gross asset or liability positions. In addition, in order to fully account for the changes in gross positions, we would need to include both short- and long-term liabilities, which significantly complicates the analysis.

[21] The median NFA to capital ratio, has also risen sharply over the past 40 years, although it did not turn positive in the 2000s. We have also looked at the ratio of mean net savings to mean capital, and the same ratio for medians. We found that the ratio of medians exhibits the same trends as discussed here, while the ratio of means does not exhibit any pronounced trends, suggesting that small and medium-size firms, as opposed to large firms, are behind the rise of net savings in the Compustat data set. These results can be found in Appendix A.



Source: Compustat

Figure 2: NFA/capital density, 2000s

firms in the 2000s have positive NFA positions.[22] Third, the distribution also features a small left-tail, with about ten percent of the firms borrowing more than half their tangible assets.

Table 1: Moments of corporate NFA/capital distribution

| NFA/K | 2000s |
|---|---|
| mean | 0.07 |
| median | -0.07 |
| Pr(NFA>0) | 43.5 |
| skeweness | 1.81 |
| std dev | 0.65 |
| 10pct | -0.51 |
| 25pct | -0.31 |
| 75pct | 0.35 |
| 90pct | 1.38 |

Are positive NFA positions concentrated within a particular segment of public firms or has the phenomenon been widespread? We look at NFA positions conditional on firm size, age, industry, and entry cohort. We find that firms in all sectors have experienced

---

[22] The corresponding number was only 27 percent in the 1970s.

an increase in their NFA, with manufacturing firms seeing their net asset positions turn positive in the 2000s. We also find that small to medium size firms, younger firms, and entrants into Compustat contributed the most to the U.S. sector becoming a net lender during the 2000s.[23] Detailed results and discussion of these findings are provided in Appendix A.[24]

Our results indicate that U.S. public firms have been holding significant amounts of internal funds on their balance sheets during the past decade. Why is this noteworthy? Consider a firm's balance sheet which, given the definition of NFA, implies that equity must be equal to NFA plus capital. Thus, positive NFA firms must have equity larger than their capital stock. These large equity positions by positive NFA firms are surprising from the financing cost point of view. Equity carries fiscal cost as both dividends and capital gains are taxed; plus has significant floatation and agency (by bringing external ownership into the company) costs. Thus from a cost perspective the ranking of financing sources is quite straightforward: first, firms should rely on internal funds; if external finance is needed, debt should be preferred to equity. The evidence presented above suggests that firms continue to carry equity even when internal funds are available.

We next develop a theoretical framework through which we will try to understand this behavior of the U.S. publicly-traded firms.

---

[23] There is an extensive empirical literature that focuses on cross-sectional determinants of corporate leverage (for instance, see Titman and Wessels (1988), Rajan and Zingales (1995), Fama and French (2002), Shyam-Sunder and Myers (1999), and Welch (2004) among others). Our data analysis does not attempt to contribute to this debate, but rather to provide a set of stylized facts on the cross-firm distribution of savings.

[24] We also investigate whether firms with foreign operations are responsible for the large positive NFA positions in the 2000s, as these firms may choose not to repatriate their foreign profits for tax reasons and instead keep the funds in their savings accounts. We find no evidence for this in the Compustat sample. In fact, NFA to capital ratios of firms with foreign operations, as reported in the income statements, are lower than those for the firms with domestic operations only. Detailed statistics are presented in the online appendix.

# 3 The model

The economy is populated by a representative household, entrepreneurs, and the government. Time is discrete and denoted by $t = 0, 1, \ldots$ We abstract from aggregate shocks.

The entrepreneurs are subject to idiosyncratic shocks and make the core decisions in our model: how much to invest and how to finance themselves. Our description of the model accordingly starts with them. The representative household supplies labor and funds to the entrepreneurs, and is used to derive factor and asset prices. Finally the government balance budget constraint closes the model.

## 3.1 Entrepreneurs

There is a continuum of risk-neutral entrepreneurs, with mass normalized to one. Each period a fraction $\varkappa > 0$ die and an identical measure of new entrepreneurs are born.

### 3.1.1 Production

Each entrepreneur owns a firm that combines capital $k$ and labor $l$ into final output according to the production function

$$f(l, k; \sigma) = \frac{z(\sigma)^{\nu+\eta} k^{\nu} l^{1-\nu-\eta}}{\nu + \eta},$$

where $z(\sigma) \in Z$ is an idiosyncratic productivity shock governed by the exogenous state $\sigma \in \Sigma$, which follows a first-order Markov stochastic process. Parameters $\nu, \eta > 0$ satisfy $\nu + \eta < 1$ and determine the income shares of labor, capital, and the entrepreneur's rents.

Labor is hired at a spot market at wage rate $w_t$. The firm pays a corporate tax rate $\tau^c$ on earnings minus capital depreciation expenses, $\delta k_t$, where $\delta > 0$ is the depreciation rate of capital. Investment is set one period in advance. In addition we introduce the possibility that a firm suffers a cash flow loss by allowing for additional after-tax expenses

$c^f(k_t;\sigma)$. Then, the firm's after-tax net revenues and capital net of depreciation are given by

$$\pi(k;\sigma) = \max_l (1-\tau^c)\left(f(l,k;\sigma) - wl - \delta k\right) + k - c^f(k;\sigma). \tag{1}$$

The additional expenses may be due to overhead costs, minimum scale requirements, product obsolescence, or, more exceptionally, liabilities or accidents. We must note that operational losses play an important role in our model. Entrepreneurs will periodically have to use finance to cover cash shortfalls, possibly in states of the world where their immediate revenue prospects are poor.

### 3.1.2 Financing

In order to obtain finance, an entrepreneur may rely on internal funds, debt, or equity issuance. Let $a_t$ denote financial asset position at date $t$, that is, $a_t > 0$ denotes positive net savings (and thus internal funds), and $a_t < 0$ denotes debt. The pre-tax gross return of savings/debt is $1 + \tilde{r} > 1$. Since interest expenses are deductible from corporate taxes due, the after-tax gross return is $1 + r = 1 + (1-\tau^c)\tilde{r}$.

We consider only risk-free, fixed-return debt. Hence we must ensure it is feasible to repay outstanding debt with probability one. The no-default condition implies the following borrowing constraint:

$$a_{t+1} \geq -\alpha, \tag{2}$$

where $\alpha$ is derived from the primitives of the model, akin to the computation of a natural debt limit for a firm. In the Appendix B we discuss the steps to derive the borrowing constraint, as well as conditions such that $\alpha$ is strictly positive and independent of the firm's state.

We model equity financing as follows. The entrepreneur can issue claims on the firm's value to the households. The terms on these claims—the shareholder payout policy—are exogenously specified. We also assume the entrepreneur retains full control of the firm's decision-making and is the residual claimant of the value of the firm at all times. In doing so we abstract from a host of corporate governance and agency issues. Let $s_{t+1}$ be the number of equity claims, or shares, issued at date $t$. At date $t+1$, after the realization of the firm's state $\sigma_{t+1}$, the present value of the shareholder distributions, per claim, is exogenously given by the function $q(k_{t+1}, \sigma_{t+1}) : \Re_+ \times \Sigma \to \Re_+$. Total equity payouts are thus $q(k_{t+1}, \sigma_{t+1})s_t$. Note we are subsuming all the various forms shareholder payout can take, e.g., dividends, shares buy-backs, capital gains, in the present value of distributions, $q$. While an exogenous payout policy is less than ideal, our approach is very flexible without compromising the tractability of the model—and it is thus very well suited for quantitative analysis. Finally, we assume that entrepreneurs cannot short themselves, $s_{t+1} \geq 0$, and total claims are bounded above, $s_{t+1} \leq 1$.

Investors price shares according to function $p(k_{t+1}, \sigma_t) : \Re_+ \times \Sigma \to \Re_+$. We will derive the price schedule later from the arbitrage condition that leaves the representative household indifferent between holding debt or equity.

### 3.1.3 The entrepreneur's problem

We are now ready to set up the entrepreneur's problem.[25] We assume entrepreneurs have risk-neutral preferences and choose plans for asset holdings $a_t$, capital $k_t$, equity $s_t$, and consumption $c_t$ to maximize

$$E_t \left\{ \sum_{j=0}^{\infty} \left(\beta_e(1-\varkappa)\right)^j c_{t+j} \right\},$$

subject to budget constraint

$$c_t + a_{t+1} + k_{t+1} + q(k_t, \sigma_t)s_t \leq \pi(k_t; \sigma_t) + (1+r)a_t + p(k_{t+1}, \sigma_t)s_{t+1} \tag{3}$$

---

[25] We view the entrepreneur as in charge of the firm so the entrepreneur's and the firm's problems are equivalent. Financial and productive assets, though, should be viewed as remaining in the firm's balance sheet—otherwise, their fiscal treatment would vary, i.e., factor returns would be subject to the income tax schedule instead of the corporate tax's.

as well as

$$\begin{aligned} c_t &\geq 0 \\ a_{t+1} &\geq -\alpha \\ s_{t+1} &\in [0,1] \end{aligned}$$

at all dates $t \geq 0$, where $\beta_e \in (0,1)$ is the inter-temporal discount factor of the entrepreneurs.

The entrepreneur's problem can be stated recursively by defining net worth,

$$\omega_{t+1} = \pi(k_{t+1};\sigma_{t+1}) + (1+r)a_{t+1} - q(k_{t+1},\sigma_{t+1})s_{t+1},$$

as the endogenous state variable for the firm's problem. Net worth summarizes all the cash inflows as well as payment obligations of the firm entering in period $t+1$. It is thus a concise summary of the internal funds the firm can tap into. Since cash flow and net financial assets are bounded below, we can show that net worth is bounded below, $\omega \geq \omega^b$. There is no upper bound for net worth, and thus the support for net worth is $\Omega = \{\omega \geq \omega^b\}$.

We proceed by splitting the recursive problem into two stages. Given state $\{\omega,\sigma\}$, the entrepreneur decides how much to invest:

$$V(\omega,\sigma) = \max_{k' \in \Gamma(\omega,\sigma)} J(k',\omega,\sigma),$$

where $V : \Omega \times \Sigma \rightarrow \Re_+$ is bounded and $\Gamma(\omega,\sigma) : \Omega \times \Sigma \rightrightarrows \Re_+$ is a correspondence with a non-empty compact image.[26] With $k'$ as given, the entrepreneur decides the best way to

---

[26] See the Appendix B for a derivation of $\Gamma(\omega,\sigma)$ as well as a detailed discussion of the recursive formulation.

finance investment, and whether to consume

$$J(k',\omega,\sigma)=\max_{c,a',s'} c+\beta E_\sigma V(\omega'(\sigma'),\sigma')$$

subject to the following constraints

$$\begin{aligned} c+a'+k' &\leq \omega+p(k';\sigma)s', \\ c &\geq 0, \\ a' &\geq -\alpha, \\ s' &\in [0,1], \end{aligned}$$

where

$$\omega'(\sigma')=\pi(k';\sigma')+(1+r)a'-q(k',\sigma')s'$$

for all $\sigma' \in \Sigma$. We denote by $\psi^x : \Omega \times \Sigma \to \Re$ the resulting policy functions for $x \in \{c,k',a',s'\}$. We also obtain a law of motion for net worth, $\psi^\omega(\omega,\sigma,\sigma')$.

### 3.1.4 Entry, exit, and firm distribution

Each period a fraction $\varkappa$ of entrepreneurs exit and an identical measure of entrants replace them. The net worth of exiting entrepreneurs is redistributed among the new entrepreneurs according to the joint distribution $G(\omega,\sigma)$ over net worth and productivity. Entering entrepreneurs must incur a fixed entry cost, $f_e$, that takes the form of an initial investment necessary to start up production. We set $f_e$ such that all new entrepreneurs find it profitable to enter.[27]

Let $F_t(\omega,\sigma)$ be the cumulative distribution function of firms defined over net worth and productivity, with support $\Omega \times \Sigma$. The borrowing constraint indeed ensures that a

---

[27] For the sake of exposition, we do not explicitly write out the underlying bequest system across entrepreneurs. To be clear, there is no equilibrium condition associated with entry. The rationale for the fixed cost is to close the balance sheet of the firm, by accruing the entrepreneur's rents to the initial investment.

firm retains positive value at all dates, and thus liquidation is never optimal.

To obtain the law of motion for the firm distribution, we combine the exit and entry dynamics with the law of motion for net worth,

$$F_{t+1}(\omega', \sigma') = \varkappa G(\omega', \sigma') + (1-\varkappa) \sum_{\sigma \in \Sigma} \mu(\sigma'|\sigma) F_t\left(\phi(\omega', \sigma, \sigma')\right) \tag{4}$$

for all $\omega', \sigma'$, where $\phi(\omega', \sigma, \sigma') = \sup\left\{\omega \in \Omega : \psi^{\omega}(\omega, \sigma, \sigma') \leq \omega'\right\}$.

## 3.2 The representative household

The representative household is infinitely-lived and values non-negative consumption $c_t^h$ and labor $l_t^h$ sequences according to

$$\sum_{t=0}^{\infty} \beta^t u\left(c_t^h, l_t^h\right)$$

where $u$ is a utility function with the standard properties and $\beta$ is the intertemporal discount factor of the household, which is set equal to $\beta_e(1-\varkappa)$, so both the entrepreneur and the representative household have the same effective intertemporal discount factor.

Households earn income from supplying labor as well as from their holdings of the firms' equity and debt. Interest income and shareholder distribution are taxed at effective rates $\tau^i$ and $\tau^e$, respectively.[28]

The household budget constraint is thus

$$c_t^h + a_t^h \leq w_t l_t^h + (1+\tilde{r}(1-\tau^i))a_{t-1}^h + T_t + \int_{\Omega\times\Sigma} \left[s_t^h p_t \left(1 + (1-\tau^e)\left(\frac{q_t}{p_t} - 1\right)\right) - s_{t+1}^h p_{t+1}\right] dF_t$$

where $a_t^h$ are the financial assets held by the household, $s_{t+1}^h$ are the shares held of firms with net worth $\omega$ and state $\sigma$, and $T_t$ transfers from the government. Above we eliminated

---

[28] Of course labor income is also taxed. In our model, though, the labor tax rate does not have any implication for the financing decisions of the firms and thus we decide to economize on notation.

explicit references to the state variables for simplicity of the notation.

The optimality conditions from the household's problem are used to derive the wage as well as the after-tax interest rate:

$$w_t = -\frac{u_t^l}{u_t^c},$$
$$1 + \tilde{r}(1 - \tau^i) = \left(\beta \frac{u_{t+1}^c}{u_t^c}\right)^{-1}.$$

Here $u^c$ and $u^l$ denote marginal utility of consumption and marginal disutility of work, respectively. Finally, there is also a first-order condition for the equity holdings

$$p(k_t(\omega), \sigma) = \left(\beta \frac{u_{t+1}^c}{u_t^c}\right) \left(p(k_t(\omega), \sigma) + (1 - \tau^e) \left(E\left\{q(k_{t+1}(\omega), \sigma')|\sigma\right\} - p(k_t(\omega), \sigma)\right)\right). \quad (5)$$

There is no risk premium in the equity price since the representative household is perfectly diversified and there is no aggregate uncertainty.

## 3.3 Government and stationary equilibrium

Finally, the government collects all tax revenues and rebates them as transfers to the household

$$\tau^c \int_{\Omega \times \Sigma} \left(f(l_t(\omega, \sigma), k_t(\omega, \sigma); \sigma) - w_t l_t(\omega, \sigma) - \delta k_t(\omega, \sigma) - r a_{t-1}(\omega, \sigma)\right) dF_t(\omega, \sigma)$$
$$+ \tau^e \int_{\Omega \times \Sigma} s_t^h(\omega, \sigma)\, p(k_t(\omega), \sigma) \left(\frac{q(k_t(\omega), \sigma)}{p(k_t(\omega), \sigma)} - 1\right) dF_t(\omega, \sigma) + \tau^i \tilde{r} a_t^h \leq T_t.$$

Tax rates are taken as given by all agents in the economy. The government budget constraint, together with market clearing, ensures aggregate resource constraints are satisfied.

Our focus in this paper is n equilibrium with a stationary distribution of firms, $F_t = F_{t+1}$, and constant aggregate consumption and output.

**Definition 1** *A* ***stationary equilibrium*** *is a stationary distribution $F$, prices $\{p, \tilde{r}, w_t\}$,* *policy functions* $\left\{\psi^a, \psi^c, \psi^s, \psi^k, \psi^\omega\right\}$, *and household allocations* $\left\{c^h, l^h, a^h, s^h\right\}$ *such that policy functions solve the entrepreneur's problem given prices and taxes,* $F$ *satisfies the law of motion (4), markets clear, and the household optimality conditions and government budget constraint are satisfied.*

# 4 Net Savings and Equity

Due to their different fiscal considerations, the firm's cost of financing will generally depend on its capital structure, unless interest, equity, and corporate tax rates satisfy a knife-edge condition. The household's optimality condition (5) equates the after-tax returns of equity and debt,

$$1 + (1 - \tau^e)\left(\frac{E_t q\left(k_t(\omega), \sigma'\right)}{p\left(k_t(\omega), \sigma\right)} - 1\right) = 1 + \left(1 - \tau^i\right)\tilde{r}.$$

This implies that creditors and shareholders do not demand the same *pre-tax* returns, which are the determinants of the cost of financing faced by the firms.[29] Namely, the cost of firms' financing through debt is $1 + \tilde{r}(1 - \tau_c)$ or $1 + r$ using the previous notation shorthand. The cost of financing through equity is

$$\rho^e = \frac{E_t q\left(k_t(\omega), \sigma'\right)}{p\left(k_t(\omega), \sigma\right)}.$$

Since both $(1 + r)$ and $\rho^e$ are determined by the household optimality conditions and tax rates alone, we will generally have that $(1 + r) \neq \rho^e$. Define the "markdown" parameter $\xi$ as the wedge in the firms' cost of financing through debt and equity,

$$\xi = \frac{(1 + r)}{\rho^e}.$$

---

[29] We have assumed the household is perfectly diversified across firms and there is no aggregate uncertainty. As a result, there is no equity risk premium and the expected return is equated across all firms.

The wedge $\xi$ summarizes all the fiscal considerations in the firm's choice to finance itself. As simple as our model is, it can generate a demand for financial assets even if the latter is fiscally disadvantageous, that is, $\xi < 1$.

To understand how the model works, we first roll back the borrowing constraint and let the entrepreneur tap into as much debt or equity as needed. Consider first the case with $\xi = 1$. The Miller-Modigliani theorem applies and thus the capital structure of the firm is indeterminate as the entrepreneur is indifferent between the two financing sources. If $\xi \neq 1$, then the risk-neutral entrepreneur will rely exclusively on the cheaper asset. For our case of interest, equity is relatively costly, $\xi < 1$, and thus the entrepreneur would finance investment exclusively with debt.[30]

We now re-introduce the borrowing constraint for the case of costly equity, $\xi < 1$. At first pass this seems of little help to generate a demand for net savings and additional equity. Debt-holders require a lower return, and the entrepreneur prefers to finance fully with debt. Only if the firm is at debt capacity the entrepreneur would have to resort to equity for additional funding. Thus the firm would follow a "pecking order" among finance sources, where internal funds would be preferred to external funds and, among the latter, debt would be preferred to equity. We would observe most firms relying heavily on debt—resorting to equity issuance only if the firm is at its maximum debt capacity. No firm would carry financial assets without retiring as much equity as possible.

However, this argument misses a key observation: the entrepreneur's problem becomes strictly concave, and thus risk considerations come into play, due to the interplay between the borrowing constraint and costly equity. Consider a firm following the pecking order described above to finance a given amount of investment. If the firm has a high net worth, investment can be financed at least in part by the firm's own savings, being thus unlikely that the firm requires more debt than the borrowing constraint allows. Hence, the firm values an additional dollar of net worth at the risk-free return $1 + r$. A firm with low net

---

[30] If $\xi > 1$, then the return on equity is lower than the return on debt (and thus savings). The entrepreneur would engage in arbitrage in this case: she would raise as much funds as possible from shareholders and simply save the proceeds.

worth, though, will likely hit its debt capacity when seeking to finance its investment, and will have to make up the shortfall by issuing equity—increasing its cost of finance. The higher finance cost not only reduces the value of the firm, but it also increases the value of an additional dollar of net worth: now one dollar allows the firm to save the expected return to equity, $(1+r)/\xi$. Thus the firm values a dollar more when it has low net worth than when it has high net worth. Indeed, the differences in the value of an additional dollar get much larger once the full dynamic program is considered, as we will discuss in further detail below, with a low net-worth firm valuing an additional dollar well above $(1+r)/\xi$.

Given that the firm's value function is concave and in the presence of uncertainty, firms will strive to accumulate net financial assets for precautionary reasons.[31] That is, firms want to build their net worth up rapidly in order to decrease the probability that they find themselves at debt capacity at future dates. Indeed, the entrepreneur delays any distributions to herself until the firm can self-finance at all future dates. Consider the first-order condition associated with the risk-free asset,

$$\lambda \geq \beta(1+r)E\left\{V'\left(\omega'(\sigma'),\sigma'\right)|\sigma\right\} \tag{6}$$

with strict equality if the firm is not at debt capacity, $a' > -\alpha$, where $\lambda$ is the Lagrangian multiplier associated with the budget constraint and thus the marginal benefit of net savings. The first-order condition associated with consumption implies that $\lambda \geq 1$. Using the envelope theorem, we can rewrite the previous first-order condition as

$$\lambda \geq E\left\{\lambda' |\, \sigma\right\}$$

where we have also used the condition $(1+r)\beta = 1$. Thus $\lambda$ is a supermartingale, and $\lambda$ converges almost surely to its lower bound. Whenever the firm is at debt capacity, one more dollar would allow it to relax the borrowing constraint, and thus it is more valuable,

---

[31] The precautionary motive here resembles closely the one found in models of household finance. See, for instance, Carroll (1997), Gourinchas and Parker (2002) and Fuchs-Schundeln (2008).

$\lambda > 1$. Thus the firm seeks to save as much net worth as possible in anticipation of states of the world where the debt capacity will bind. Only when there is zero probability that the borrowing constraint is ever binding, that is, when

$$\lambda = E\left\{\lambda' \middle| \sigma\right\} = 1$$

for all $\sigma \in \Sigma$, there will be distributions to the entrepreneur.[32] Financial assets allow firms to build up net worth over time without introducing further risk or incurring decreasing returns to capital.

We turn now our attention to the demand for equity. We argue that firms will be willing to pay a premium for equity if dividend distributions and net worth are positively correlated. In fact, under this condition firms will find it useful to fund additional financial asset holdings with equity revenues. This large deviation from the pecking order is crucial for the model to match the high levels of net financial assets observed in the 2000s. Consider the first-order condition associated with equity issuance,

$$p(k', \sigma)\lambda = \beta E\left\{V'\left(\omega'(\sigma'), \sigma'\right) q(k', \sigma') | \sigma\right\},$$

where we have assumed positive issuance, $s' > 0$, and dropped the arguments where there is no confusion possible. We can rewrite this expression in terms of the covariance (Cov),

$$p(k', \sigma)\lambda = \beta E\left\{V'\left(\omega'(\sigma'), \sigma'\right)\right\} E\left\{q(k', \sigma')\right\} + \beta \mathrm{Cov}\left(V'\left(\omega'(\sigma'), \sigma'\right), q(k', \sigma')\right),$$

Now assume that the firm is not at debt capacity, $a > -\alpha$, and thus the last dollar of equity revenues is effectively funding the financial assets of the firm. Using the definition

---

[32] There exists a level of financial assets, $a^*$, such that the net return $ra^*$ is sufficient to cover all finance needs in all states. Thus the entrepreneur can maintain the financial asset position $a^*$ with probability one and consume the excess cash flow.

of the wedge $\xi$ and dividing through by $p(k', \sigma)$ we obtain

$$\lambda - \beta E\left\{V'\left(\omega'(\sigma'), \sigma'\right)\right\} E\left\{\frac{q(k', \sigma')}{p(k', \sigma)}\right\} = \lambda - \xi^{-1}\beta(1+r)E\left\{V'\left(\omega'(\sigma'), \sigma'\right)\right\} < 0,$$

where the last inequality is signed by using the first-order condition associated with the risk-free asset (equation (6)) when the firm is not a debt capacity. Clearly, both equity and debt optimality conditions can be satisfied simultaneously only if

$$\text{Cov}\left(V'\left(\omega'(\sigma'), \sigma'\right), \frac{q(k', \sigma')}{p(k', \sigma)}\right) < 0.$$

This requires both that the value function $V$ is strictly concave, and shareholder payouts are positively correlated with net worth.

As discussed earlier, the concavity arises naturally in our model due to the borrowing constraint and the cost of equity. The positive correlation of equity payouts with net worth makes equity valuable to the firm due to its insurance properties. Namely, since shareholders payouts decrease when the firm has low cash flow or losses, equity delivers some financial relief to the entrepreneur exactly in the states where the firm will have lower net worth and thus is likely to face a higher finance cost. As a result, entrepreneurs are willing to pay an additional cost for equity—akin to an insurance premium. In the calibration of the model we assume that shareholder distributions and cash flows are positively correlated. As we show below this assumption has strong empirical support.

It perhaps remains counter-intuitive that firms find it useful to issue equity, at a cost, to insure themselves against the cost of equity financing in future periods. The key is that one additional dollar available for a firm with low net worth allows the firm to reduce equity reliance in the present *and future periods.* In order to finance its investment, a firm with low net worth has no choice but to commit a large share of its future cash flow to shareholder distributions. There is thus nothing but a trickle for the firm to crawl out from the borrowing constraint, building its net worth very slowly and resorting to equity repeatedly. One more dollar of net worth allows the firm to reduce equity issuance in the present period, which in turn frees additional cash flow in the next period and again reduces equity outstanding in that period, and so on.[33]

The logic of the model highlights the idea, emphasized by Hennessy and Whited (2005), that it is essential to view the capital structure decision in the context of a fully specified dynamic problem. Firms with a moderate level of net worth may have no chance of being at debt capacity *next* period or, more generally, in the short term. A model with a short horizon would need huge cash flow shocks in order to induce demand for equity among firms with some net savings. In a fully forward-looking model, even firms that can self-finance in the short term strive to accumulate further NFA and value the insurance properties of equity.

There remains the question, though, of whether our model can generate the large *positive* net savings observed among firms that rely on equity. We answer this question with a quantitative evaluation of our model.

# 5 Calibration

We turn now to the core question of the paper: can our model replicate the cross-firm distribution of NFA and generate positive aggregate NFA as observed for the period 2000-2007? As the model is taken to the task, we have to take a stand on two crucial aspects of the calibration. First, we have to quantify the fiscal cost of equity relative to debt. Second, we have to decide which moments to target with the productivity process. The remaining parameters regarding technology and entry are set to standard or straightforward values.

---

[33] Appendix C contains a simple example illustrating the dynamics of equity and the trade-off with debt.

### 5.1 The fiscal cost of equity

In Section 3 we assumed an "effective" tax rate on all shareholder distributions but the actual U.S. tax code is far from being that simple. Fortunately, it is quite straightforward to map a more nuanced view of equity taxation into the relative cost of equity, $\xi$. In Appendix B we derive the equity price households demand such that the after-tax return of debt and equity is equated accounting for dividend, capital-gains, and interest-income tax rates, denoted $\tau^d$, $\tau^g$, and $\tau^i$, respectively. We also need to take into consideration inflation as well as the split between dividends and capital gains for equity distributions. The resulting markdown is

$$\xi = \frac{(1-\tau^d)\left((1-\tau^c)\tilde{R} - \gamma_a\right)}{(1-\tau^i)\tilde{R} - (1-\tau^g)\gamma_a},$$

where $\gamma_a$ is the growth rate of the equity price, and $\tilde{R}$ is the interest rate on corporate debt, both in nominal terms. While the inflation rate does not enter the expression explicitly, both the nominal interest rate and the asset price growth rate vary with inflation.

We pick tax and interest rates representative of the period 2000-2007 for the U.S. and relying both on statutory rates and estimates from the public finance literature. Our choices are summarized in Table 2. Let us start with the corporate tax rate, $\tau^c$. Due to investment not being expended for tax purposes, the corporate tax rate directly impacts the firm's decision beyond its implications for the relative cost of equity. In the U.S. the corporate tax code specifies a flat tax rate of 34 percent from \$335,000 to \$10 million, and caps the marginal rate at 35 percent.[34] The literature has an ample consensus on setting $\tau^c = .34$, and we follow suit.

Interest income is taxed at the federal income tax rate and thus varies across investors. Wealth, though, is heavily concentrated on the right tail, so we choose a tax rate close to the top rate, $\tau^i = .34$, which is slightly higher than estimates of the average marginal tax

---

[34] Only small businesses and S corporations get a rate below 30 percent.

Table 2: Taxes and interest rate — Baseline calibration

| | Parameter | Value |
|---|---|---|
| Corporate tax | $\tau^c$ | 0.34 |
| Dividend tax | $\tau^d$ | 0.15 |
| Interest income tax | $\tau^i$ | 0.34 |
| Capital gains tax | $\tau^g$ | 0.15 |
| Pre-tax nominal interest rate | $\tilde{R}$ | 0.07 |
| Equity markdown | $\xi$ | 0.82 |

rate across households.[35] The pre-tax nominal interest rate is set at 7 percent, while the inflation rate is at 2 percent. This results in an after-tax real rate of 2.5 percent.

Now we turn to the taxation of equity. The period 2000-2007 includes an important tax reform, the Jobs and Growth Tax Relief Reconciliation Act of 2003. The act equated dividend and capital gains tax rates at 15 percent, although there are several caveats. First, Poterba (1987) argues that the effective capital-gains tax rate is one fourth of the statutory rate, due to the gain referral and step-up basis at death. Second, some low-income households are subject to a lower dividend tax rate of 12 percent, while some other households may end up with a rate above 15 percent due to the alternative minimum tax.[36] Third, some corporate investors do not pay dividend taxes, and the share of equity held by them has increased sharply over time.[37] We note, though, that most estimates track closely the statutory rates in the decade of the 2000s. We thus decide to go with the statutory rates, $\tau^d = .15$ and $\tau^g = .15$. If anything, these rates are likely to overstate slightly the fiscal cost of equity.

---

[35] Poterba (2002) and NBER TAXSIM estimates tend to be just below 30 percent. Some bonds are tax-exempt, which reduces the average marginal tax rate. However, corporate bonds are always fully taxed.

[36] For example, Poterba (2004) reports an average marginal tax rate on dividends of 18 percent. A similar situation arises regarding capital gains taxes.

[37] For example, pension funds and other fiduciary institutions. See McGrattan and Prescott (2005) for a discussion.

## 5.2 Shareholder payouts

We assume that the present value of shareholder payout, $q$, is proportional to the firm's cash flow and capital holdings, $\pi(k_{t+1};\sigma_{t+1})$:

$$q(k_{t+1},\sigma_{t+1}) = \frac{1}{1-\beta}\pi(k_{t+1};\sigma_{t+1}).$$

While admittedly ad-hoc, our specification aims to be a parsimonious representation of the shareholder payout policies observed in the data.[38] In our Compustat data, we find that total payout is strongly positively correlated with contemporaneous firm's cash flow (correlation coefficient of 0.67) and tangible assets (correlation coefficient of 0.55).[39] The positive association between firm's performance and its shareholder payouts is also backed by a long literature. In his seminal work Lintner (1956) showed that firm earnings were the most important determinant of any change in dividends, a finding later confirmed by other studies: Fama and Babiak (1968), Fama and French (2001), Denis and Osobov (2008). Skinner (2008) generalized these findings by showing that corporate earnings determine total firm payout (dividends and repurchases). Allen and Michaely (2003) provide a comprehensive overview of this literature.

The positive comovement between the firm's performance and shareholder payout is also important from the model standpoint. As discussed in Section 4 this is the key property that makes equity valuable to the firm. We should note that the precautionary motive would remain even if we had specified equity as a full state-contingent contract; firms would still tolerate some residual risk because of the additional cost of equity $\xi < 1$. In our specification the linear relationship with cash flows further limits the insurance

---

[38] The value of the constant of proportionality between payouts and $\pi$ is irrelevant. Recall that $q$ is the present value per share, and thus any scaling of $q$ simply results in a change of units for shares. Our choice simply renders shares comparable to infinitely-lived assets.

[39] We compute shareholder distributions as the sum of common dividends and equity repurchases. The latter is obtained as the total expenditure on the purchase of common and preferred stocks minus any reduction in the value of preferred stocks outstanding. We also excluded observations with negative preferred shock redemption value and with negative values for the purchase of common or preferred stock. This definition is borrowed from Grullon and Michaely (2002) and is very close to that used in Jagannathan et al. (2000) who also included preferred stocks in their measure of the repurchase activity.

properties of equity. We later make sure that $\pi(k_{t+1};\sigma_{t+1}) \geq 0$.

It is also useful to contrast our functional form for shareholder payout with the optimal payout policy in the model. The optimal payout policy would backload all dividend payments until the firm has accumulated enough assets to finance itself in all future states—typically only after a long time. In short, the expected return of a dollar of the firm's financial assets is higher than the household's return on her savings as long as the firm may encounter the borrowing constraint with positive probability in the future. Being fully diversified across firms, the household is thus happy to defer dividends until the return of a dollar at the firm is equated to the real interest rate. This policy is clearly counterfactual. Instead we proceed with the shareholder payout function specified above, which enables us to replicate its properties in the data in a parsimonious way.

## 5.3 Technology, preferences, and entry parameters

We first discuss the parameters governing technology, which are set to match standard values in the literature. We postpone the calibration of the productivity process for the next subsection. We start with the parameterizations of the production function. We set $\eta = .12$ to equate the entrepreneurs' rents to the share of dividends over GDP. Parameter $\nu$ is set to .2. Assuming entrepreneur rents are split 50-50 between capital and labor income accounts, this results in the standard total capital income share of 36 percent. The depreciation rate is set to 6 percent.

For the household preferences we use an utility function of the form $u(c - h(l))$ such that the labor supply is given simply by $h'(l) = w$. This implies that the computation of the stationary equilibrium does not require specifying $u$ and $h$, and the wage rate can be normalized to 1 without any loss of generality. The discount rate $\beta$ is pinned down by our earlier choice of the interest rate. The resulting value .96 is standard.

Next we turn to our calibration of the entry parameters. As we work with a stationary distribution, the entry rate in the model also serves as exit rate. In the data there is a slight upward trend in the number of firms, so the entry rate is slightly above the exit rate. We set our exit/entry parameter at 5 percent, closer to the exit rate in the Compustat data. For the net worth distribution of entrants we use a Pareto distribution with curvature parameter $\varsigma$ equal to 1.3, which matches the relative capital holdings of entrants to incumbents. The entry cost $f_e$ is set to match the 10th percentile of the distribution of NFA over capital.[40] Table 3 summarizes the parameter choices reported in this subsection.

Table 3: Technology and entry parameters — Baseline calibration

| | Parameter | Value |
|---|---|---|
| Discount factor | $\beta$ | 0.96 |
| Entrepreneur rent | $\eta$ | 0.12 |
| Depreciation rate | $\delta$ | 0.06 |
| Capital elasticity | $\upsilon$ | 0.20 |
| Exit rate | $\varkappa$ | 0.05 |
| Entry distribution | $\varsigma$ | 1.3 |
| Entry cost | $f_e$ | 4.28 |

## 5.4 Productivity process

The productivity process is a key aspect of the calibration. As our primary interest lies in the firms' financing decisions, it is important that we match the firms' observed financing needs. Looking at the data, we identify two key drivers of the firms' financing needs: negative cash flows and large investment expenses in excess of the firms' contemporaneous cash flows.

First, we observe that a substantial fraction of firms experience a negative cash flow. In any given year during the 2000-2007 period, about 25 percent of the firms in our sample had a negative cash flow, defined as operating income before depreciation expenses. The

---

[40] Parameters $\varsigma$ and $f_e$ are matched to moments that require us to evaluate the full model, and thus it would be more correct to say that they are jointly calibrated with the productivity process. However the relationship between the parameters and the moments is very tight, so we feel comfortable linking them at this point.

transition rate from positive to negative cash flow is also quite high at 6 percent. Firms must balance the operating loss with either a decrease in assets or an increase in liabilities. In particular, cash flow shortfalls will provide a strong basis for the precautionary demand for financial assets.[41]

Second, firms occasionally have opportunities to expand their operations, perhaps by acquiring a foundering competitor or by upgrading their production process because a new technology has become available. These opportunities often present themselves without any relationship to the contemporaneous cash flow of the firm and usually require investment expenditures that are larger than the firm's net revenues. For the period 2000-2007, we find that about 22% of the firms with positive cash flow incurred investment expenditures in excess of their cash flow in a given year. Among those, more than half had investment expenditures totaling 150% or more of their cash flow. Firms that want to take advantage of these opportunities need to finance their increase in assets without having the benefit of an immediate increase in cash flows.

Unfortunately, we find that the standard specification used in the literature does not allow either for operational losses or for forward-looking investment opportunities and thus does not generate a realistic level of financing needs. Under the usual autoregressive process, firms' investment is driven by contemporaneous positive productivity shocks. Investment can then be easily financed from the firm's own net revenues, since the latter also increase with the productivity shock. In short, it is quite easy for firms to self-finance under the usual productivity specifications, as financing needs arise only when the firm is experiencing a cash-flow windfall.

We instead propose a productivity process that directly incorporates the possibility of operational losses and investment opportunities, and it is thus capable of generating realistic levels of financing needs in the model. More precisely, productivity is modeled as

---

[41] Lins et al. (2010) document that CFOs use cash to guard against future negative cash flow shocks. Lines of credit, due to financial covenants, are not a good substitute, as documented by Sufi (2009). Our operational losses are akin to liquidity shocks in Boileau and Moyen (2009), with the exception that Boileau and Moyen (2009) model liquidity shocks as stochastic expenses faced by firms, while we use the frequency of negative cash flows as our measure of liquidity shocks.

a ladder where investment opportunity shocks lead a firm to move up the ladder, while operational losses lead a firm to drop off the ladder. We assume productivity takes one of $n$ levels, $\{z_1, z_2, \ldots, z_n\}$. We capture operational losses with state $n = 1$, setting $z_1 = 0$, so for simplicity there are zero net revenues in that state, and cost expenses $c^f(k, z_1)$ are such that equation (1) becomes:

$$\pi(k, z_1) = 0$$

for all $k$. Note that this still implies that a firm experiencing operational loss has a negative cash flow. We set $c^f(z, k) = 0$ for all other states and levels of investment, thus ensuring that net revenues are non-negative everywhere but in state 1. The probability of operational losses for a firm with productivity level $z$ is denoted by $\phi(z) > 0$. Our specification for operational losses, while stark, is very parsimonious and keeps the portfolio decision in the firm's problem simple. It also implies that the no-default borrowing constraint is constant across firms, as it suffices to show that the firm can repay the outstanding debt in the event of operational losses.

Investment opportunities are modeled as a step up the productivity ladder. A firm with productivity level $z$ has a probability $\iota(z)$ to receive an investment opportunity shock. Such a firm will then either transition to operational losses (with probability $\phi(z)$) or will upgrade their productivity by one level. That is, a firm with productivity level $z_t = z_i$ that receives an investment opportunity will transition to productivity level $z_{t+1} = z_{i+1}$ next period with probability $1-\phi(z_i)$, or $z_{t+1} = z_1$ with probability $\phi(z_i)$. A firm without an investment opportunity remains at the same productivity level, $z_{t+1} = z_i$ next period with probability $1 - \phi(z_i)$, or $z_{t+1} = z_1$ with probability $\phi(z_i)$.[42]

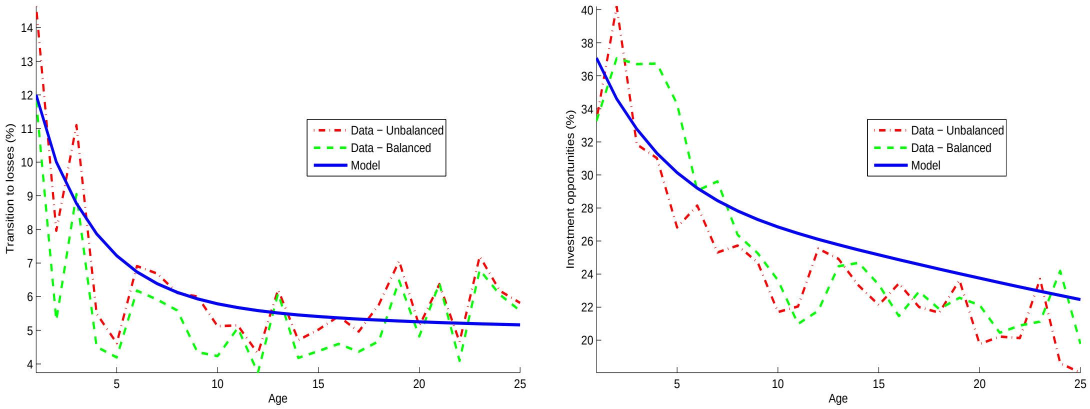
Finally, we set productivity levels $z_2, z_3, \ldots, z_n$ to be equally log-spaced, with growth rate $\gamma_z$, that is, $z_i = \gamma_z^{i-2} z_2$. This guarantees that there is no hard-wired relationship between firm size and growth rates.

---

[42] Firms at state $z_1$ automatically have an investment opportunity, so they transition to $z_2$ unless they suffer operational losses again. Firms with the highest productivity level, $z_n$, do not receive further investment opportunities.

In order to discipline the transition probabilities $\phi(z_i), \iota(z_i) : i = 1, \ldots, n$ we turn to the age profiles for operational losses and investment opportunities observed in the data. The reason to rely on firm's age is twofold. First, the data show that the probability of operational losses and investment opportunities is clearly decreasing with age, ranging from 12 % to 4 % and from 36 % to 22 % for operational losses and investment opportunities, respectively. We thus automatically match a salient feature of the data through our calibration strategy. Second, age evolves exogenously, allowing us to calibrate the transition probabilities before solving the model.

Figure 3 displays the probability of a firm transitioning into operational losses and the probability of a firm experiencing an investment opportunity for the model and the data, both using a balanced and unbalanced Compustat panel, for ages up to 25 years. The model matches these age profiles quite closely. In the calibration we also ensured to match the unconditional transition probability into operational losses, 6%, and the share of firms with investment expenditures exceeding their cash flow, about 22% of firms with positive cash flow.[43]



(a) Operational losses

(b) Investment opportunities

Figure 3: Operational losses and investment opportunities by age

Table 4 reports the transition probabilities governing the productivity process.

---

[43] Because investment is an endogenous variable in the model, the probability transition $\iota_i$ does not need to coincide exactly with the share of firms with investment expenditures in excess of their cash flow in the model. We do find, though, that the difference between the two is very small.

Finally we set the growth rate of productivity along the ladder, $\gamma_z$, to reproduce an average growth rate in revenues of about 5% among firms with positive cash flow. The level $z_2$ is normalized to 1. We use nine states for the productivity process, enough to generate a right tail in revenues, yet keep the computational time in check.[44]

Table 4: Productivity process — Baseline calibration

| | State $i$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Operational loss $\phi_i$ | .13 | .12 | .04 | .04 | .04 | .035 | .035 | .035 | .03 |
| Investment opportunity $\iota_i$ | 1 | .3 | .25 | .2 | .2 | .18 | .15 | .1 | 0 |

Lastly, we want to emphasize that since we are targeting facts for publicly traded firms, we look only at firms in our model that have a positive probability of issuing equity. In our model firms with very high net worth can rely exclusively on self-financing for investment—and thus have no need to tap outside investors. We consider these firms to be private equity and drop them from our sample.[45]

# 6 Results

## 6.1 Net financial assets

Does our model replicate the distribution and positive aggregate level of NFA observed during 2000-2007? Yes, it does. Table 5 reports the model predictions along with the corresponding data moments. Our model reproduces the large fraction of firms with a positive NFA position, 43.5 percent in the data versus 41.8 percent in the model. The

---

[44] We should note that our interest in firms' financing choices necessitates the use of cash flows, as opposed to revenues or value added, when calibrating the productivity process. However, in Section 6 we show that with our calibration the model generates the distribution of revenues that is very close to the data. Overall, we believe our calibration is broadly consistent with Midrigan and Xu (2014).

[45] Note the model's sample includes all firms with debt. Thus the censoring from the model does not help to generate positive NFA in the sample. The fraction of firms dropped is usually very small, less than 5 percent.

model's performance regarding the central moments is also very good. The mean NFA to capital is just a tad below the data, and the median is matched exactly.[46]

Table 5: Model and Data - Net financial assets to Capital

| | 2000s | |
|---|---|---|
| | Data | Model |
| mean | 0.07 | 0.06 |
| median | -0.07 | -0.07 |
| $\Pr(NFA > 0)$ | 43.5% | 41.8% |
| std dev | 0.65 | 0.67 |
| 10pct | -0.51 | -0.51 |
| 25pct | -0.31 | -0.39 |
| 75pct | 0.35 | 0.23 |
| 90pct | 1.38 | 1.65 |

The model does a remarkable job at matching the full distribution of NFA over K in the data. The standard deviation in the model and in the data is very close, so we are confident that our simple productivity process is capable of generating enough variation in corporate finance portfolios. Both the first and third quartiles are very close to the data.[47] We overshoot the 90th percentile, albeit not by a large margin.

Figure 4 presents the histogram of the NFA to capital as generated by the model. As in the data, the distribution is skewed to the right and features a long right tail, with a small number of firms having very large NFA holdings relative to their productive assets. The model generates a left tail as well, albeit slightly shorter than in the data where a small fraction of firms are observed to have negative NFA positions in excess of 70 percent of their assets. In the model, all firms share the same debt limit, which limits our ability to generate enough dispersion among firms that rely heavily on debt.

We should emphasize that our model can rationalize the corporate sector as a net lender only through the mechanism highlighted in Section 4. No productivity process

---

[46] We compute the moments from a simulation of 50,000 firms drawn from the stationary distribution. To ensure consistency we treat the simulated data as we treated the data in Section 2.

[47] Recall we used the fixed entry parameter $f_e$ to directly target the 10th percentile, although this has surprisingly little effect on the overall shape of the distribution.

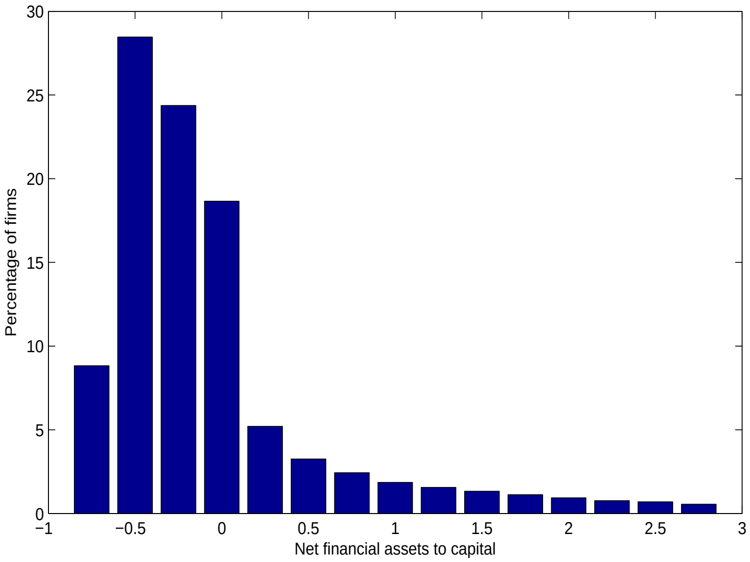


Figure 4: NFA to capital histogram, model

would generate positive NFA if we were to equate taxes across debt and equity or drop the borrowing constraint. If equity had no fiscal costs, all firms would spurn debt. At the same time, with the fiscal cost of equity but without a borrowing constraint, all firms would finance only with debt, as it is the cheaper finance source. We should also note that without equity payouts providing partial insurance, we would also not observe firms with positive NFA actively relying on equity.

Quantitatively, though, our specification for productivity is key to the model's fit. Motivated by the data, we modeled operational losses and investment opportunities as the two key drivers of the firms' demand for finance. We imposed a minimal structure with a very parsimonious specification and calibrated the transition probabilities using the age profiles observed in the data for the frequency of both operational losses and large investment expenditures—so we did not target any moment of the NFA distribution. The fact that the model performs very well suggests that the link between financing needs and balance sheets is very tight, and that operational losses and investment opportunities effectively capture the relevant shocks for firms' financing structure.

## 6.2 Other firm characteristics

We now turn our attention on how the model performs regarding variables other than NFA. Since our process for productivity is admittedly non-standard, it is important to check the model's predictions for variables that are typically used in the literature to calibrate the productivity process, such as employment, revenues, and investment.

Table 6 reports various unconditional moments for investment and revenues in the model and data: the mean of a given variable relative to the mean capital, both in the model and in the data; the same for standard deviations; and the autoregressive coefficients.

Model's overall performance is very satisfactory. The model matches closely the first and second moments for investment and revenues. Perhaps the only noticeable difference is that investment is, on average, a bit higher than in the data as well as slightly less persistent. We are comfortable with the small gap on both counts since there are some reasons to think that investment and capital may be understated in the data compared with the model. First, firms may be renting equipment and machinery, so structures are disproportionately represented in the category of tangible assets. Second, bookkeeping rules for investment and capital do not always correspond to their economic counterparts and are sometimes shaped by fiscal considerations of their own—most notoriously in the treatment of depreciation.

Table 6: Model and Data–Other variables

| | Model | Data |
|---|---|---|
| | ratio of means | |
| investment/K | 0.12 | 0.08 |
| revenues/K | 0.95 | 0.96 |
| | ratio of std dev | |
| investment/K | 0.12 | 0.12 |
| revenues/K | 0.96 | 0.92 |
| | autocorrelation | |
| investment | 0.65 | 0.74 |
| revenues | 0.97 | 0.99 |

The model's performance extends to employment and cash flows, since both variables are very closely tied to the firm's revenues both in the data and in the model. The model closely matches the standard deviation of log employment, 1.25 in the data versus 1.24 in the model, and is virtually spot on the auto-correlation coefficient for employment. We are thus confident that our process, despite its simplicity, is capturing the dispersion in size in the data. Regarding cash flows, the model slightly overstates the persistence in cash flows, 0.87 in the data versus 0.95 in the model, suggesting that there is some stochastic variation in expenses that the model may be missing.[48]

Given their key role in our calibration, we also check how operational losses vary across several firm's characteristics. Figure 5 shows how the probabilities of a firm transitioning into operational losses varies with capital, total assets, revenues, employment, net financial assets and NFA to capital ratio, sorted in quintiles, in the model and in the data. The model tracks closely the decreasing relationship with capital, total assets, revenues and employment. This, of course, reflects the strong relationship of these variables with firm's age, which we used in our calibration. It is still remarkable how closely the model tracks the data.

The two bottom charts in Figure 5 display how operational losses vary with net financial assets, in levels and as a ratio to tangible assets. The data suggest a non-monotonic, hump-shaped relationship with net financial assets, which disappears once we normalize by the firm's capital. The relationship between operational losses and net financial assets is also quite weak in the model.

Lastly, we check the predictions of the model for the shareholder's payout and compare them with the data. These are summarized in Table 7. The mean payouts in the data are small at about 4% annually as a share of mean capital, not very volatile at 6% relative to capital and quite persistent (with autocorrelation coefficient of 0.73). The model's predictions are quite close to these numbers.

---

[48] The model is spot on regarding revenues, so expenses are likely to explain the lower auto-correlation coefficient in the data.

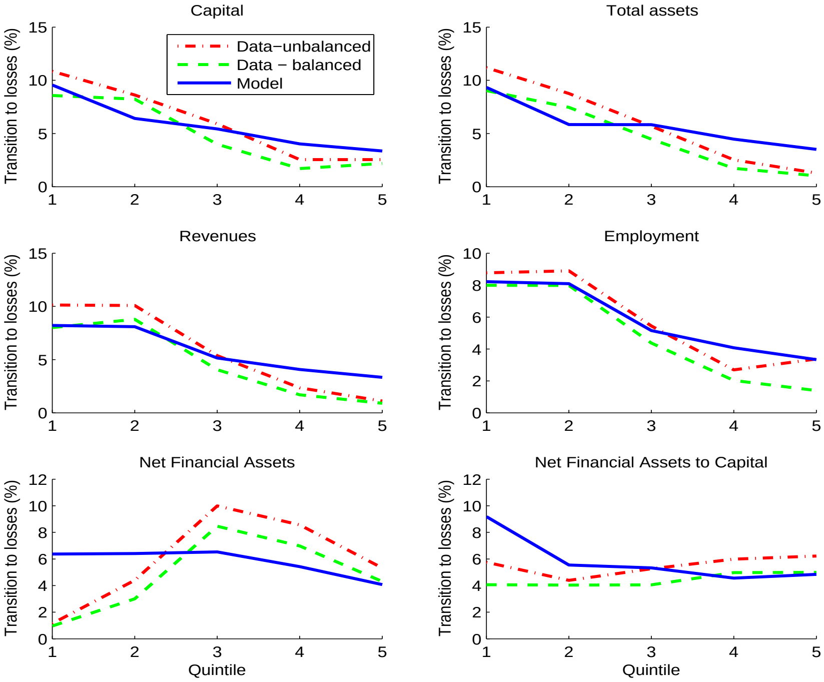


Figure 5: Operational losses and firm's characteristics

We also check how shareholder distributions correlate with firms' characteristics. In the model we posit that the shareholder payout is proportional to the firm's cash flow and capital holdings, $\pi(k_{t+1}; \sigma_{t+1})$, a relationship strongly motivated by the data. Not surprisingly, the model predicts large positive correlations of payout with capital (equal to 0.89) and cash flows (equal to 0.92), with the comovement being stronger with cash flow as in the data. In the model shareholder payout are also strongly positively correlated with revenues and book equity, both of which are in close correspondence with the data.[49]

Table 7: Model and Data–Shareholder payouts

| | Model | Data |
|---|---|---|
| mean(distrib)/mean(K) | 0.06 | 0.04 |
| std(distrib)/std(K) | 0.05 | 0.06 |
| autocorr | 0.94 | 0.73 |

---

[49] We measure equity in the model at the book value (BE) from the firm's balance sheet. This corresponds the closest to book equity measure we have in the Compustat's balance sheet statements. It is equal to the total stockholders' equity.

## 6.3 Which firms have positive net savings?

While the model provides a good fit to the distribution of NFA across firms and matches the properties of several other variables, we next investigate whether the model also matches the characteristics of firms conditional on their financial position. That is, we ask: Does the model predict the right *joint* distribution of NFA and key variables, such as investment, equity, and revenues? To answer this question we revisit the model's predictions *conditional* on NFA and compare them with the data.

Let us start with a quick look at the model predictions. Figure 6 plots the policy functions for NFA and capital, as function of net worth, for a firm in state $z_4$ without an investment opportunity (solid lines marked No inv.opp.).[50] We have also included book equity, and the ratio of NFA to capital.

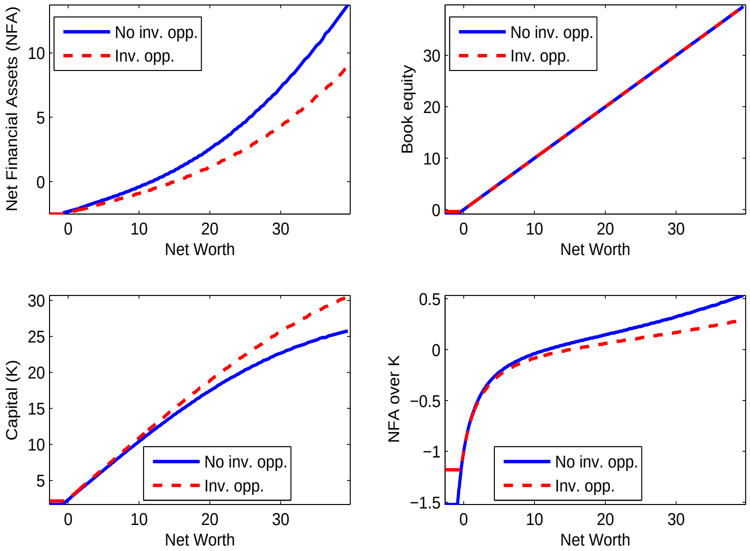


Figure 6: Policy functions

Firms with low net worth are net borrowers and their investment is low. As a result, these firms also have low book equity and revenues (not shown). Their smaller scale reflects their higher cost of external finance. As firms build their net worth, they increase

---

[50] State $z_4$ roughly corresponds to the median productivity in the model. All the policy functions are qualitatively very similar across states. We only display the lower half of the support for net worth where most firms lay.

both capital and NFA roughly at the same pace, and eventually become net savers. The latter clearly have more capital and book equity, and thus more revenue. Since both NFA and capital are increasing as a function of net worth, it is an open question whether NFA to capital increases with net worth. The lower-right plot displays the ratio of NFA to capital, which is clearly increasing and turns positive for sufficiently high levels of net worth. Summarizing, the model predicts that higher-NFA firms have higher revenues, investment, and book equity.

Figure 6 also plots the policy functions of a firm in the same productivity state $z_4$ but with an investment opportunity available (dashed lines marked Inv.opp.). This allows us to see how firms adjust their positions, and how this adjustment is different depending on whether the firm has enough net worth to have accumulated net savings or not. Not surprisingly, firms react to an investment opportunity by increasing investment, drawing from their net savings or borrowing, and possibly raising some additional equity. Note how firms with low and high net worth differ in their capacity to take advantage of the investment opportunity. Firms with high net worth are capable of boosting their investment further as they have more spare borrowing capacity or even net savings available. This translates into higher revenue growth rates for firms with positive net savings. The latter also build their net worth much faster, which translates into higher equity growth as well.

Table 8 compares the quantitative predictions of the model with the data by reporting the ratio of means of investment, revenues, book equity and annual changes in book equity, for firms with positive and non-positive NFA. The positive NFA firm invest more than non-positive NFA firms, in the order of 28 percent on average. The model is almost spot on in matching the difference. We also see that firms with positive net savings are more valuable and collect higher revenues in the model as well as in the data. The model, though, tends to understate the differences in book equity values. Firms with positive NFA also see their equity increase at a more rapid pace. As discussed before, investment opportunity shocks are key in the model to generate these differences. That said, operational losses and the inherent non-linearities of the law of motion for net worth also contribute to the disparity in equity adjustments.

Table 8: Model and Data - Conditional means

| | Model | Data |
|---|---|---|
| Ratio X \| NFA$>0$ to X \| NFA$\leq 0$ : | | |
| investment/K | 1.26 | 1.28 |
| revenues/K | 1.10 | 1.31 |
| BE/K | 2.32 | 2.99 |
| ($\Delta$BE)/K | 1.43 | 1.21 |

Overall, we view these findings as strong evidence that we captured well the key determinants of NFA positions in the data with a very parsimonious model.

# 7 Corporate net savings in the 1970s

Finally we explore why the corporate sector was a net debtor in the 1970s, with much fewer firms holding positive NFA positions, as reported in Section 2. We focus on two possible causes. First, statutory dividend tax rates in the 1970s were substantially higher: Since our model has emphasized the importance of capital income taxation for firms' savings decision, the time-variation in the fiscal burden on equity provides us with an opportunity to explore the quantitative predictions of the model's main mechanism. Second, several researchers have documented an increase in the idiosyncratic risk for firms in the 1990s and 2000s, and some work have linked such development to the increase in the firms' cash holdings.[51] We indeed find that firms in our data set exhibit lower risk in the 1970s through a lower probability of experiencing operational losses. We consequently re-calibrate the productivity process and document the resulting model's predictions.

We do not aim to provide an exhaustive account of all changes behind the shift in NFA holdings between the 1970s and the 2000s. The model is simply not equipped to explore

---

[51] See Bates et al. (2009), Boileau and Moyen (2009) and, more recently, Zhao (2015) and Bates et al. (2016).

all the hypotheses that have been put forth: secular changes in the cost of investment, intangible assets, product market competition, cost of innovation, switch to just-in-time inventory system.[52]

## 7.1 Dividend taxes

There have been two main forces easing the fiscal burden on equity over the past 40 years. First, there were significant cuts in the top marginal income tax rates in the 1980s and, starting in 2003, dividend income was taxed separately from income and at a rate significantly below income tax rates.[53] The second force has been emphasized by McGrattan and Prescott (2005), who argue that changes in regulation have had an important impact on the effective marginal tax rates by increasing the share of equity held by fiduciary institutions that pay no taxes on dividend income (or capital gains).[54]

We rely on Poterba (1987) for effective tax rate estimates and set the dividend tax rate $\tau^d$ corresponding to the 1970s at 0.28. Our baseline calibration for the 2000s used a tax rate of $\tau^d = 0.15$, the statutory rate for most of the period. There is no statutory rate for the 1970s, since dividend income was not taxed separately. The effective tax rate is instead estimated from marginal income tax rates and the distribution of income across households.[55] Thus according to our calculations, the decline in dividend taxation during the 1980s and 1990s, up to the Jobs and Growth Tax Relief Reconciliation Act of 2003, halved the effective dividend tax rate. We recompute our markdown parameter for the 1970s with the higher tax rate, which renders equity more expensive relative to debt, $\xi = 0.69$. The estimates for the effective dividend tax in the 1970s from McGrattan and Prescott (2005) are even higher.

---

[52] See, respectively, Karabarbounis and Neiman (2012); Falato et al. (2013); Morellec et al. (2013) and Della Seta (2013); Ma et al. (2014) and Lyandres and Palazzo (2011); and Gao (2015).

[53] The public finance literature has documented this shift extensively as early as in Poterba (1987). The latter change was brought up by the Jobs and Growth Tax Relief Reconciliation Act of 2003, which spurred a large literature that we cannot hope to summarize here.

[54] See Rydqvist et al. (2011) for cross-country evidence on the role of tax policies on the decline of direct stock ownership by households.

[55] See Poterba (2002) for further details and an updated time series.

We keep all the remaining parameters of the model unchanged.[56] We should mention that tax rates on capital gains have also been estimated to be slightly higher in the 1970s.[57] However, the effect on the relative cost of equity to debt is quite small, and we feel comfortable focusing on dividend taxes. A more important omission is the higher statutory corporate tax rate observed in the 1970s, on the vicinity of 46% compared with 34% in the 2000s. However, changing corporate tax rate in our model requires a concurrent adjustment in the intertemporal discount factor $\beta$, and thus compounds the effects of both factors. We provide a detailed discussion of this issue and some exercises with the higher corporate tax rate in the Appendix.

Table 9 reports the moments from the distribution of NFA to capital from the model evaluated at $\tau^d = 0.28$ and compares them with the data. The shift toward debt in the model is remarkably close to the data. The model predicts the mean NFA to capital in the 1970s at $-0.06$ while the corresponding number in the data is $-0.12$. Roughly speaking, the model captures a bit more than two thirds of the dramatic drop in the average NFA position relative to the 2000s. The model is actually getting most of the shift in the distribution right, with the median in the data and the model being very close. Similarly, just above 32 percent of the firms in the model have a positive NFA in the 1970s, down from the 42 percent in the 2000s, and very close to the 27 percent in the data in the 1970s.

For such a stark exercise as ours, the overall fit of the distribution is surprisingly good across all percentiles but the top ones. Indeed, it is the very top 10 percent of firms in the NFA to K distribution that are responsible for most of the differences between model and data: the observed standard deviation for the 1970s is significantly lower than predicted by the model, and the average NFA to K ratio is higher in the model than in the data.

Of course we did not expect the model to generate a perfect fit to the distribution of NFA in the 1970s given that many other changes took place in the last 40 years. However,

---

[56] For the exercise, we treat the borrowing constraint as a parameter. As the support for the net worth distribution changes, we also adjust the entry distribution to replicate the entrants' characteristics in the 2000s.

[57] See Poterba (2002).

Table 9: Dividend tax $\tau^d = .28$

|  | 1970s |  |
|---|---|---|
| NFA/K | Data | Model |
| mean | -0.12 | -0.06 |
| median | -0.17 | -0.16 |
| $\Pr(NFA > 0)$ | 26.9% | 32.3% |
| std dev | 0.39 | 0.59 |
| 10pct | -0.50 | -0.52 |
| 25pct | -0.34 | -0.44 |
| 75pct | 0.02 | 0.07 |
| 90pct | 0.29 | 1.00 |

this simple exercise illustrates the power of the mechanism in the model, as it shows how an increase in the relative cost of equity to debt is, by itself, capable of reproducing the shift in firms' NFA position from a net lender in the 2000s to a net borrower in the 1970s.

Finally, we can compute the implications of the higher dividend tax rates for the capital-to-output ratio, and thus investment. We find the capital-to-output ratio in the 1970s to be slightly below its value in the 2000s—2.7 percent to be precise.[58] We conclude that the cost of capital increases with the dividend tax rate, as one would expect, but the response is quite muted.

It is perhaps not surprising that a higher dividend tax rate increases the cost of capital and thus decreases investment, but the sharp response of net savings and the mild response of investment deserve further discussion. Clearly, everything else equal, the more expensive equity is, the more firms rely on debt to finance investment. The shift toward debt is magnified by the fact that now it takes longer for firms to build up internal funds and thus, on average, they have to rely more on external finance. Therefore, NFA positions in the model decline substantially. The large shift toward debt in the firms'

---

[58] This is in line with the U.S. data, where the capital-to-output ratio in the data has been broadly stable in the last 40 years. However, our model can offer only an incomplete picture of the growth experience of the U.S. as we lack an explicit formulation for intangible investment. See McGrattan and Prescott (2005).

balance sheet also implies that firms are able to insulate the cost of capital from the increase in the cost of equity, thus leaving investment relatively unchanged.

## 7.2 Idiosyncratic firm risk

Several studies have argued that the idiosyncratic risk for firms has increased over the last few decades. Comin and Philippon (2006) and Irvine and Pontiff (2009) document how volatility of sales, cash flows, and employment growth for Compustat firms has sharply increased. Campbell et al. (2001) also report similar increases in the volatility of firm-level returns.[59] Moreover, the increased risk has been previously linked to the rise in corporate assets, in Boileau and Moyen (2009) and Bates et al. (2016), among others.

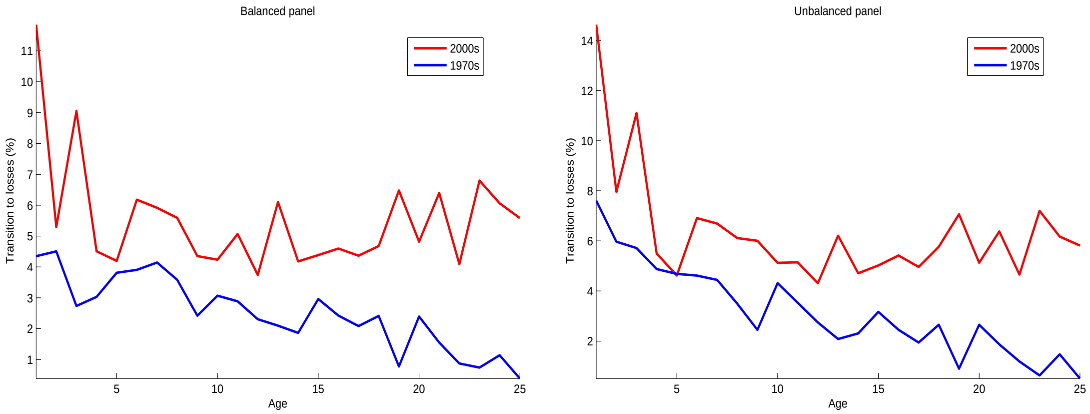
In our data set we found a substantially lower risk profile for firms in the 1970s, driven by a lower frequency of operational losses. The share of firms with operating losses in the 1970s is 7.4%, about one third that of the 2000s; and the probability a firm with positive net revenues transitions to a net loss roughly halved, to 3.8%. Figure 7 displays the probability of transition to losses by age, for both 2000s and 1970s, and both for the balanced panel (left plot) and the unbalanced panel (right plot). The profile for loss risk is clearly lower in the 1970s. It is also noticeable how the probability of transition to a loss steadily decreases with age in the 1970s, while it is roughly flat in the 2000s past the first 10 years.

In contrast, we did not find systematic differences in the age profile for investment opportunities—the other factor driving our productivity process. The Appendix reports the profiles and documents the data construction.

In order to capture the lower idiosyncratic risk in the 1970s we set to recalibrate the productivity process. We follow the same steps as for the baseline calibration documented in Section 5, but now targeting the profile reported in Figure 7. Given that we did not observe substantial differences in the profile for investment opportunities, we only adjust

---

[59] It is worth noting that these findings are not free of contention: Davis et al. (2007) argue that privately held firms display the opposite behavior. See also Thesmar and Thoenig (2011).



(a) Balanced panel (b) Unbalanced panel

Figure 7: Operational losses by age: 1970s and 2000s

the parameters for the operational losses. The remaining parameters are set to their baseline values but for the dividend tax rate, which is set to 28%.

Table 10 reports the new values for the probability of an operational loss for each state, $\phi_i$. Not surprisingly, they are substantially lower than in the baseline calibration. Figure 8 shows how the model fits the profile of operational losses (left panel) and investment opportunities (right panel). By design, the model tracks very closely the pattern in operational losses. The fit for investment opportunities remains quite good as well.[60]

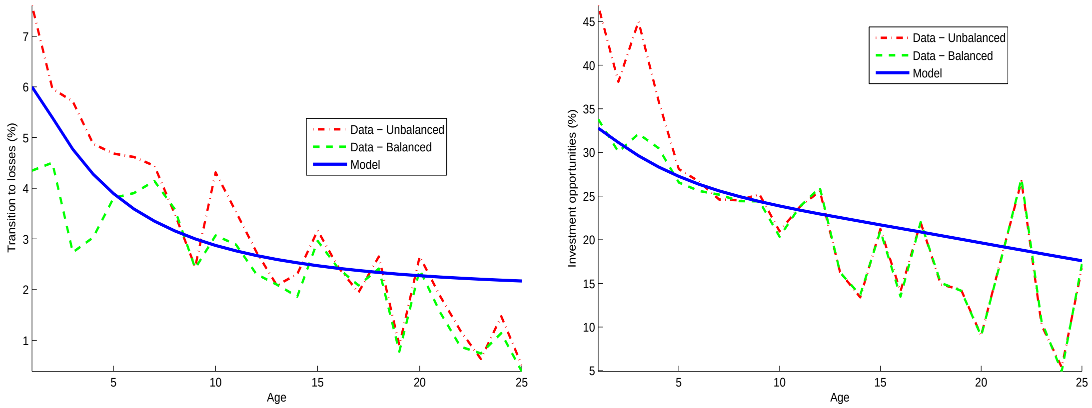
Table 10: Alternative productivity process - Operational loss $\phi_i$

| | State $i$ | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Baseline (2000s) | .13 | .12 | .04 | .04 | .04 | .035 | .035 | .035 | .03 |
| Less loses (1970s) | .10 | .06 | .03 | .02 | .02 | .015 | .015 | .015 | .015 |

Table 11 reports the results of the simulation (last column) using the recalibrated productivity process together with a dividend tax rate of 28%. For comparison, the results of the baseline calibration for the 2000s as well as the exercise with only a higher

---

[60] Note that while we did not change the parameters directly governing the arrival of investment opportunities. Changing the operational losses process tweaks a bit the pattern of investment opportunities as a function of age.



(a) Operational losses (b) Investment opportunities

Figure 8: Operational losses and investment opportunities by age - 1970s

dividend tax rate are included. The first column reports the data counterparts to the key moments.

Table 11: Lower idiosyncratic risk in 1970s

| | Data | Model | | |
|---|---|---|---|---|
| | 1970s | 2000s | 1970s | |
| | | Baseline | Baseline | Lower risk |
| *NFA/K* | | | | |
| mean | -0.12 | 0.06 | -0.06 | -0.11 |
| median | -0.17 | -0.07 | -0.16 | -0.14 |
| $\Pr(NFA > 0)$ | 26.9% | 41.8% | 32.3% | 31.4% |
| std dev | 0.39 | 0.67 | 0.59 | 0.57 |
| 10pct | -0.50 | -0.51 | -0.52 | -0.62 |
| 25pct | -0.34 | -0.39 | -0.44 | -0.55 |
| 75pct | 0.02 | 0.23 | 0.07 | 0.02 |
| 90pct | 0.29 | 1.65 | 1.00 | 0.52 |

The results are certainly remarkable: The new calibration closes the gap regarding average NFA/K between the 1970s and 2000s, reducing the model's prediction with only the dividend tax adjustment by five percentage points to $-.11$, pretty much spot on with the observed average NFA/K ratio of $-.12$. In short, firms are now comfortable holding large amounts of debt, no longer rushing to build up a large NFA position for precautionary motives and taking full advantage of the favorable fiscal treatment of debt.

At the same time, the fit of the new calibration is not perfect. The share of firms with positive NFA remains a bit too high, and so does the median NFA/K. The bottom quartile of firms by NFA position have too much debt, as it can be seen from the 10th and 25th percentiles. However, the new calibration does quite a bit to reduce the excessively thick right tail that the calibration with only higher dividend taxes had.

# 8 Conclusions

In this paper we documented the positive net financial position of the U.S. corporate sector and publicly-traded firms in the last decade. To explain this fact we develop a model capable of generating simultaneous demand for equity and net savings, despite the fiscal advantages associated with debt. Our hypothesis emphasizes the risk considerations firms face in their capital structure decisions. In particular, demand for net savings is driven by a precautionary motive as firms seek to avoid being financially constrained in future periods. Simultaneously, firms value equity as it provides partial insurance against investment risk. We showed that our model can match quantitatively the net lender position of the corporate sector for the period of 2000-2007 and replicates the overall distribution of NFA during that period very well.

Going forward, we believe the model provides the groundwork to study a number of questions. First, we would like to set the changes in the saving behavior of the corporate sector in the broader context of the whole economy. For example, the rise of corporate net savings broadly coincides with a fall in the personal savings rate for U.S. households. How are these phenomena related? What are the implications for aggregate savings and investment?

We would also like to provide an in-depth exploration of the forces behind an increase in corporate savings over the past 40 years. We have conducted a simple check of the model's mechanism by allowing for a change in the relative cost of equity to debt through the tax channel and showing that it can account for the changes in NFA over time. No doubt there are other costs associated with equity, and it is possible that they have changed over the last 40 years as well.[61] Other factors, such as firm-level uncertainty, and the availability of investment opportunities, etc. have also changed over time. We hope to explore the relative importance of these various factors in future work.

---

[61] Examples are issuance cost, adverse selection, loss of control, etc.

# References

**Allen, Franklin and Roni Michaely**, “Payout policy,” in G.M. Constantinides, M. Harris, and R. M. Stulz, eds., *Handbook of the Economics of Finance*, Vol. 1 of *Handbook of the Economics of Finance*, Elsevier, March 2003, chapter 7, pp. 337–429.

**Almeida, Heitor, Murillo Campello, and Michael S. Weisbach**, “The Cash Flow Sensitivity of Cash,” *Journal of Finance*, 08 2004, *59* (4), 1777–1804.

**Auten, Gerald**, “Capital gains Taxation,” Technical Report, Department of Treasury 1999.

**Bates, Thomas W., Chinghung (Henry) Chang, and Jianxin Daniel Chi**, “Why Has the Value of Cash Increased Over Time?,” Working paper, SSRN 2016.

**—, Kathleen M. Kahle, and René M. Stulz**, “Why Do U.S. Firms Hold So Much More Cash than They Used To?,” *Journal of Finance*, October 2009, *64* (5), 1985–2021.

**Boileau, Martin and Nathalie Moyen**, “Corporate Cash Savings: Precaution versus Liquidity,” Cahiers de recherche 0953, CIRPEE 2009.

**Bolton, Patrick, Hui Chen, and Neng Wang**, “A Unified Theory of Tobin’s q, Corporate Investment, Financing, and Risk Management,” *The Journal of Finance*, 2011, *66* (5), 1545–1578.

**Brennan, Michael J and Eduardo S Schwartz**, “Optimal Financial Policy and Firm Valuation,” *Journal of Finance*, July 1984, *39* (3), 593–607.

**Campbell, John Y., Martin Lettau, Burton G. Malkiel, and Yexiao Xu**, “Have Individual Stocks Become More Volatile? An Empirical Exploration of Idiosyncratic Risk,” *The Journal of Finance*, 2001, *56* (1), 1–43.

**Carroll, Christopher D**, “Buffer-Stock Saving and the Life Cycle/Permanent Income Hypothesis,” *The Quarterly Journal of Economics*, February 1997, *112* (1), 1–55.

**Chetty, R. and E. Saez**, "Dividend Taxes and Corporate Behavior: Evidence from the 2003 Dividend Tax Cut," *Quarterly Journal of Economics*, 2005, *120* (3), 791–833.

**Chetty, Raj and Emmanuel Saez**, "The effects of the 2003 dividend tax cut on corporate behavior: interpreting the evidence," *American Economic Review*, 2006, *96* (2), 124–129.

**Choe, Hyuk, Ronald W. Masulis, and Vikram Nanda**, "Common stock offerings across the business cycle : Theory and evidence," *Journal of Empirical Finance*, June 1993, *1* (1), 3–31.

**Comin, Diego and Thomas Philippon**, *NBER Macroeconomics Annual 2005*, Vol. 20, Cambridge, MA: MIT Press,

**Cooley, Thomas F. and Vincenzo Quadrini**, "Financial Markets and Firm Dynamics," *American Economic Review*, December 2001, *91* (5), 1286–1310.

**Covas, Francisco and Wouter Den Haan**, "The Role of Debt and Equity Finance over the Business Cycle," CEPR Discussion Papers 6145, C.E.P.R. Discussion Papers February 2007.

**Davis, Steven J., John Haltiwanger, Ron Jarmin, and Javier Miranda**, *NBER Macroeconomics Annual 2006*, MIT Press,

**DeAngelo, Harry and Ronald Masulis**, "Optimal capital structure under corporate and personal taxation," *Journal of Financial Economics*, 1980, *8* (1), 3–29.

**_ , Linda DeAngelo, and Toni M. Whited**, "Capital structure dynamics and transitory debt," *Journal of Financial Economics*, February 2011, *99* (2), 235–261.

**Denis, David J. and Igor Osobov**, "Why do firms pay dividends? International evidence on the determinants of dividend policy," *Journal of Financial Economics*, July 2008, *89* (1), 62–82.

**Desai, Mihir A., C. Fritz Foley, and James R. Hines**, "A Multinational Perspective on Capital Structure Choice and Internal Capital Markets," *Journal of Finance*, December 2004, *59* (6), 2451–2487.

**Faccio, Mara and Jin Xu**, "Taxes and Capital Structure," *Journal of Financial and Quantitative Analysis*, 6 2015, *50*, 277–300.

**Falato, Antonio, Dalida Kadyrzhanova, and Jae W. Sim**, "Rising intangible capital, shrinking debt capacity, and the US corporate savings glut," Finance and Economics Discussion Series 2013-67, Board of Governors of the Federal Reserve System (U.S.) 2013.

**Fama, Eugene F. and Harvey Babiak**, "Dividend Policy: An Empirical Analysis," *Journal of the American Statistical Association*, 1968, *63* (324), 1132–1161.

**_ and Kenneth R. French**, "Disappearing dividends: changing firm characteristics or lower propensity to pay?," *Journal of Financial Economics*, April 2001, *60* (1), 3–43.

**_ and _** , "Testing Trade-Off and Pecking Order Predictions About Dividends and Debt," *Review of Financial Studies*, March 2002, *15* (1), 1–33.

**Fan, Joseph P. H., Sheridan Titman, and Garry Twite**, "An International Comparison of Capital Structure and Debt Maturity Choices," *Journal of Financial and Quantitative Analysis*, 2012, *47* (01), 23–56.

**Frank, Murray Z. and Vidhan K. Goyal**, *Trade-off and Pecking Order Theories of Debt*, Elsevier Science,

**Fuchs-Schundeln, Nicola**, "The Response of Household Saving to the Large Shock of German Reunification," *American Economic Review*, 2008, *98* (5), 1798–1828.

**Gamba, Andrea and Alexander Triantis**, "The Value of Financial Flexibility," *Journal of Finance*, October 2008, *63* (5), 2263–2296.

**Gao, Huasheng, Jarrad Harford, and Kai Li**, "Determinants of Corporate Cash Policy: A Comparison of Private and Public Firms," Working Papers 1722123, SSRN 2010.

**Gao, Xiaodan**, "Corporate Cash Hoarding: The Role of Just-in-Time Adoption," Working Paper, National University of Singapore Business School 2015.

**Gomes, Joao F.**, "Financing Investment," *American Economic Review*, 2001, *91* (5), 1263–1285.

**Gorbenko, Alexander S. and Ilya A. Strebulaev**, "Temporary versus Permanent Shocks: Explaining Corporate Financial Policies," *Review of Financial Studies*, July 2010, *23* (7), 2591–2647.

**Gourinchas, Pierre-Olivier and Jonathan A. Parker**, "Consumption Over the Life Cycle," *Econometrica*, January 2002, *70* (1), 47–89.

**Gourio, Francois and Jianjun Miao**, "Firm Heterogeneity and the Long-Run Effects of Dividend Tax Reform," *American Economic Journal: Macroeconomics*, 2010, *2*, 131–168.

**— and —**, "Transitional Dynamics of Dividend and Capital Gains Tax Cuts," *Review of Economic Dynamics*, April 2011, *14* (2), 368–383.

**Graham, John R.**, "Debt and the marginal tax rate," *Journal of Financial Economics*, May 1996, *41* (1), 41–73.

**—**, "Do personal taxes affect corporate financing decisions?," *Journal of Public Economics*, August 1999, *73* (2), 147–185.

**—**, "Taxes and Corporate Finance: A Review," *Review of Financial Studies*, 2003, *16* (4), 1075–1129.

**—, Mark T. Leary, and Michael R. Roberts**, "A Century of Capital Structure: The Leveraging of Corporate America," Working Papers 2223302, SSRN 2012.

**Gravelle, Jane G.**, "The Corporate Tax: Where Has it Been and Where is it Going?," *National Tax Journal*, December 2004, *57* (4), 903–923.

**Grullon, Gustavo and Roni Michaely**, "Dividends, Share Repurchases, and the Substitution Hypothesis," *Journal of Finance*, 08 2002, *57* (4), 1649–1684.

**Hennessy, C. A. and T. M. Whited**, "How Costly is External Financing? Evidence from a Structural Estimation," *Journal of Finance*, 2007, *62*, 1705–1745.

**Hennessy, Christopher A. and Toni M. Whited**, "Debt Dynamics," *Journal of Finance*, 2005, *60* (3), 1129–1165.

**Irvine, Paul J. and Jeffrey Pontiff**, "Idiosyncratic Return Volatility, Cash Flows, and Product Market Competition," *Review of Financial Studies*, 2009, *22* (3), 1149–77.

**Jagannathan, Murali, Clifford P. Stephens, and Michael S. Weisbach**, "Financial flexibility and the choice between dividends and stock repurchases," *Journal of Financial Economics*, September 2000, *57* (3), 355–384.

**Jermann, Urban and Vincenzo Quadrini**, "Macroeconomic Effects of Financial Shocks," *American Economic Review*, 2012, *102* (1), 238–71.

**Kalemli-Ozcan, Sebnem, Bent Sorensen, and Sevcan Yesiltas**, "Leverage across firms, banks, and countries," *Journal of International Economics*, 2012, *88* (2), 284–298.

**Karabarbounis, Loukas and Brent Neiman**, "Declining Labor Shares and the Global Rise of Corporate Savings," NBER Working Papers 18154, National Bureau of Economic Research, Inc June 2012.

**Khan, Aubhik and Julia K. Thomas**, "Credit Shocks and Aggregate Fluctuations in an Economy with Production Heterogeneity," *Journal of Political Economy*, 2013, *121* (6), 1055 – 1107.

**Korajczyk, Robert A. and Amnon Levy**, "Capital structure choice: macroeconomic conditions and financial constraints," *Journal of Financial Economics*, April 2003, *68* (1), 75–109.

**Lins, Karl, Henri Servaes, and Peter Tufano**, "Wat drives corporate liquidity? An international survey of cash holdings and lines of credit," *Journal of Financial Eeconomics*, 2010, *98*, 160–176.

**Lintner, J.**, "Distribution of incomes of corporations among dividends, retained earnings, and taxes," *American Economic Review*, 1956, *46*, 97–113.

**Lyandres, Evgeny and Berardino Palazzo**, "Cash Holdings, Competition, and Innovation," forthcoming, Journal of Financial and Quantitative Analysis 2011.

**Ma, Liang, Antonio S. Mello, and Youchang Wu**, "Industry Competition, Winner's Advantage, and Cash Holdings," Working paper, University of Wisconsin-Madison 2014.

**McGrattan, Ellen R. and Edward C. Prescott**, "Taxes, Regulations, and the Value of U.S. and U.K. Corporations," *Review of Economic Studies*, 2005, *72*, 767–796.

**Midrigan, Virgiliu and Daniel Yi Xu**, "Finance and Misallocation: Evidence from Plant-Level Data," *American Economic Review*, February 2014, *104* (2), 422–58.

**Miller, Merton**, "Debt and Taxes," *Journal of Finance*, 1977, *32* (2), 261–75.

**Modigliani, Franco and Merton H. Miller**, "Corporate income taxes and the cost of capital: A correction," *American Economic Review*, 1963, *53*, 433–443.

**Morellec, Erwan, Boris Nikolov, and Francesca Zucchi**, "Competition, Cash Holdings, and Financing Decisions," Working paper 13-72, Swiss Finance Institute Research Paper 2013.

**Niskanen, Mervi and Tensie Steijvers**, "Managerial ownership effects on cash holdings of private family firms," Working Papers, University of Eastern Finland 2010.

**Opler, Tim, Lee Pinkowitz, Rene Stulz, and Rohan Williamson**, "The determinants and implications of corporate cash holdings," *Journal of Financial Economics*, April 1999, *52* (1), 3–46.

**Philippe, Benhima Kenza Bacchetta and Celine Poilly**, "Corporate Cash and Employment," 2014. Working paper, University of Lausanne.

**Poterba, James**, "Tax Policy and Corporate Saving," *Brookings Papers on Economic Activity*, 1987, *2*, 454–504.

_ , *Handbook of Public Economics*, Vol. 3, Elsevier Science,

_ , "Taxation and Corporate Payout Policy," *American Economic Review*, 2004, *94* (2), 171–175.

**Rajan, Raghuram G and Luigi Zingales**, "What Do We Know about Capital Structure? Some Evidence from International Data," *Journal of Finance*, December 1995, *50* (5), 1421–60.

**Randolph, William**, "Corporate Income Tax Rates," Technical Report, Congressional Budget Office 2005.

**Riddick, Leigh A. and Toni M. Whited**, "The Corporate Propensity to Save," *Journal of Finance*, 2009, *64*, 1729–1766.

**Rydqvist, Kristian, Joshua Spizman, and Ilya Strebulaev**, "Government Policy and Ownership of Financial Assets," October 2011. Working paper.

**Sanchez, Juan M. and Emircan Yurdagul**, "Why are corporations holding so much cash?," *The Regional Economist*, Jan 2013.

**Seta, M. Della**, "Cash and Competition," Working paper, Tilburg University 2013.

**Shourideh, Ali and Ariel Zetlin-Jones**, "External Financing and the Role of Financial Frictions over the Business Cycle: Measurement and Theory," June 2012. Working paper, Carnegie Mellon.

**Shyam-Sunder, Lakshmi and Stewart C. Myers**, "Testing static tradeoff against pecking order models of capital structure," *Journal of Financial Economics*, 1999, *51*, 219–244.

**Skinner, Douglas J.**, "The evolving relation between earnings, dividends, and stock repurchases," *Journal of Financial Economics*, March 2008, *87* (3), 582–609.

**Slemrod, Joel**, "Are corporate tax rates, or countries, converging?," *Journal of Public Economics*, 2004, *88* (6), 1169 – 1186. {OTPR}.

**Sufi, Amir**, "Bank Lines of Credit in Corporate Finance: An Empirical Analysis," *Review of Financial Studies*, 2009, *22* (3), 1057–1088.

**Thesmar, David and Mathias Thoenig**, "Contrasting Trends in Firm Volatility," *American Economic Journal: Macroeconomics*, 2011, *3*, 143–180.

**Tirole, Jean**, *The Theory of Corporate Finance*, Princeton University Press, 2006.

**Titman, Sheridan and Roberto Wessels**, "The Determinants of Capital Structure Choice," *Journal of Finance*, March 1988, *43* (1), 1–19.

**_ and Sergey Tsyplakov**, "A Dynamic Model of Optimal Capital Structure," *Review of Finance*, 2007, *11* (3), 401–451.

**Uhlig, Harald and Fiorella De Fiore**, "Corporate Debt Structure and the Financial Crisis," 2012 Meeting Papers 429, Society for Economic Dynamics 2012.

**Welch, Ivo**, "Capital Structure and Stock Returns," *Journal of Political Economy*, February 2004, *112* (1), 106–131.

**Whited, Toni M.**, "External finance constraints and the intertemporal pattern of intermittent investment," *Journal of Financial Economics*, September 2006, *81* (3), 467–502.

**Zhao, Jake**, "Accounting for the corporate cash increase," Working Paper, Stony Brook University 2015.

# Appendix: Not for publication

# A Data

In this section we describe our data work in more detail. Our firm-level analysis uses the Compustat data set for the 1970-2007 period. As in Hennessy and Whited (2005), Gourio and Miao (2010) we use the following criteria to restrict our working sample. First, we focus only on U.S. firms whose capital is above 50,000 USD, whose equity is non-negative, and whose sales are positive. Second, we exclude firms that according to Standard Industry Classification (SIC) belong to finance, insurance and real estate sector (SIC classification is between 6000 and 6799); regulated utilities (SIC classification is between 4900 and 4999); and information technology and telecommunication services firms (SIC classification of 7370-7379, 4800-4899, and 3570-3579).

If the SIC classification is not available, we then use North American Industry Classification System (NAICS) to exclude the firms belonging to the above three industries. In particular, finance, insurance and real estate firms are identified as those under NAICS sector codes 52 and 53; utilities are those with NAICS sector code 22; while information technology and telecommunication services are identified with sector code 51. If both SIC and NAICS classification codes were missing, we allocated the firm into sectors according to its Global Industry Classification Standard (GICS). Thus, we excluded firms with GICS classification of 40 (Financials); 55 (Utilities); 45 and 50 (Information Technology and Telecommunication Services, respectively).

We begin by summarizing the properties of the aggregate net financial assets (NFA) to capital ratio in the Compustat data set. We construct NFA as the difference between financial assets and liabilities. Financial assets are composed of cash and short-term investments, other current assets, and account receivables (trade and taxes). Liabilities are computed as the sum of debt in current (due within one year) liabilities and other current liabilities; long-term debt; and account payable (trade and taxes). Capital stock is obtained as the sum of the firm's gross value of property, plant and equipment; its total investment and advances; unamortized value of intangible assets; and total inventories. Equity is obtained as the value of common and preferred stockholders' equity. All our variables of interest are measured as a ratio of capital.[62]

Figure A1 summarizes our findings. It plots two ratios: the ratio of average NFA to average capital; and the ratio of median NFA to median capital. We must keep in mind that while the ratio of means gives us a measure of NFA to capital that is closest to the Financial Accounts calculation, it is also heavily influenced by the outliers – firms with large capital and/or NFA.[63] It is easy to see from Figure A1 that these large firms are borrowing, on net, 25 percent of their capital, and that this level has remained relatively stable over time. Contrasting this with the Financial Accounts pattern for corporate NFA suggests several possibilities. First, small and medium-sized firms in the Compustat sample are behind the rise in NFA. We verify this conjecture by looking at the median NFA to median capital, which allows us to control for the outliers in both variables. Indeed the ratio of medians exhibits a clear upward trend over time. NFA are rising steadily over time, although they do not turn positive in the 2000s as the Financial Accounts series does. Furthermore, when we explicitly contrast the levels of NFA to capital for small and medium-sized firms with those of large firms (see Figure A3), we find clear support for the idea that small and medium-sized firms are responsible for the increase in NFA to capital over the past 40 years.

The second possibility is that private firms, which are not in the Compustat sample, contribute to the increase in NFA to capital. The balance sheet data for private firms, however, is limited, but the recent work by Gao et al. (2010) suggests that these firms

---

[62] Detailed analysis of the size of the Compustat sample, its industry composition, computation of capital-output ratios, and in-depth decompositions of NFA in both the Financial Accounts and Compustat data, etc. are provided in the online appendix available at http://faculty.arts.ubc.ca/vhnatkovska/research.htm

[63] For this reason, our preferred aggregate measure of NFA in the Compustat sample is the mean and median of the ratio, which we reported in the main text.

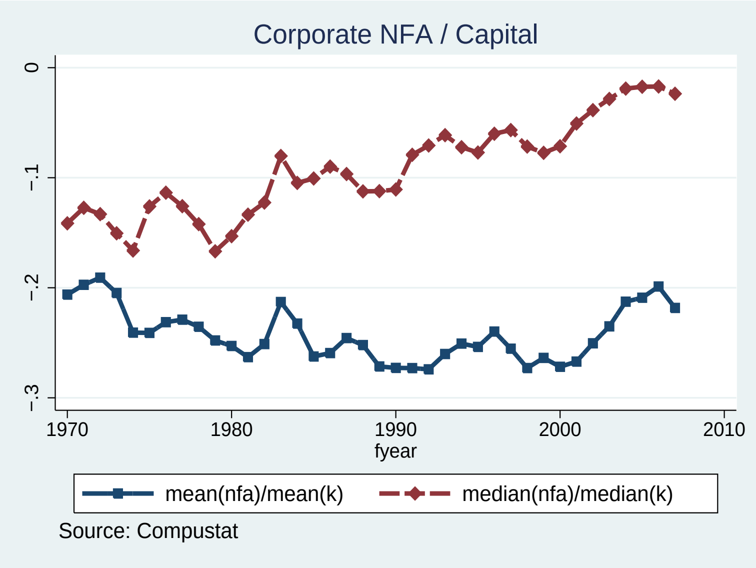


Figure A1: U.S. non-financial, non-utilities, non-technology corporate NFA to K

may not have contributed much to the rise in NFA to capital in the U.S. corporate sector. In particular, Gao et al. (2010) using a sample of U.S. public and private firms during the 2000-2008 period show that on average private firms hold less than half as much cash as public firms do.[64] While this work primarily concerns firms' cash holdings, rather then NFA, it is still informative since, as we show later, an increase in cash holdings and other short-term investments contributed the most to the increase in NFA.

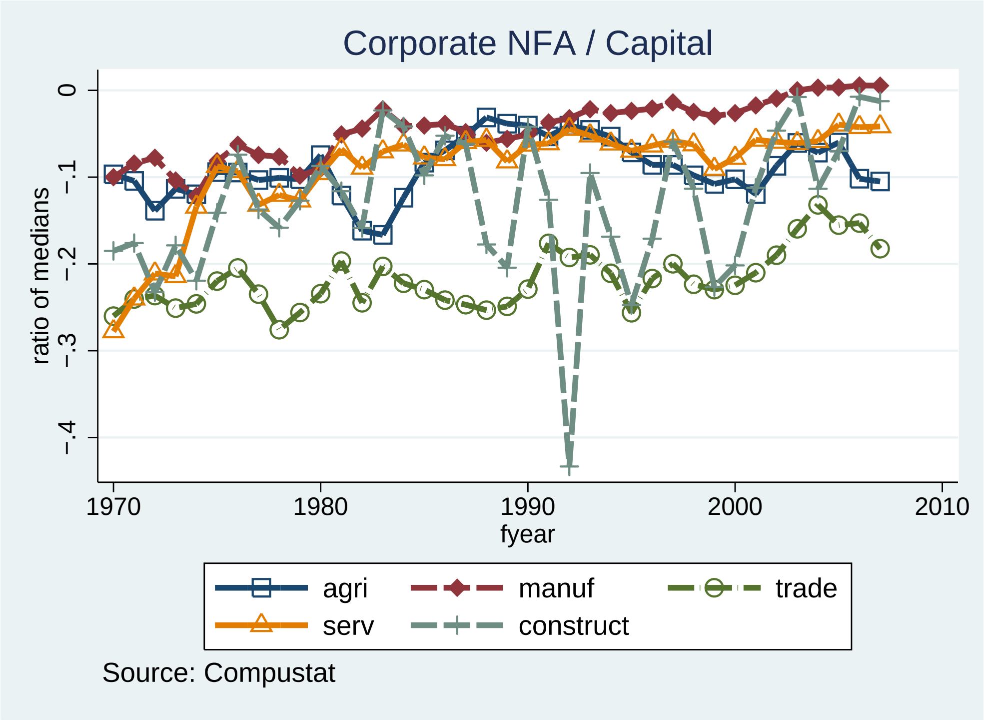
Which firms are behind the rise in corporate NFA? We turn to this question next and study NFA positions conditional on firm industry, size, age and entry cohort.

Figure A2 plots the ratio of median NFA to median capital in five industries: Agriculture and Mining; Manufacturing; Trade, Transportation and Warehousing; Services; and Construction. Several notable features of the data stand out. First, the increase in NFA to capital is characteristics of all industries, with the exception of construction, which shows a clear break in the series in the late 1980s-early 1990s. However, we have few observations for this industry and thus do not argue that this is a robust finding. Manu-

---

[64] Niskanen and Steijvers (2010) using a sample of private family firms in Norway find that an increase in firm size is associated with a decrease in cash holdings, a feature that we also document for NFA in our data set of public U.S. firms.

facturing and Services sectors, on the other hand, show the most pronounced increase in NFA over our sample period.



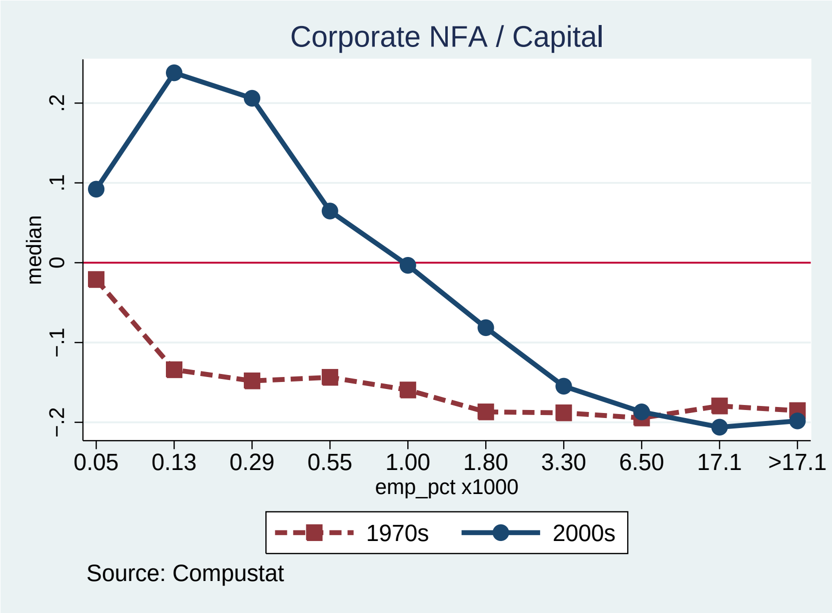
Source: Compustat

Figure A2: U.S. corporate NFA to capital by industry

Second, there is some heterogeneity in the level of NFA to capital across industries. For instance, firms in the Trade, Transportation and Warehousing industry have consistently had the lowest level of NFA to capital during the 1970-2007 period. Firms in the Manufacturing sector (the largest sector in our sample) have exhibited one of the highest levels of NFA to capital throughout the sample period and, in fact, have seen their NFA positions turn positive in the 2000s. Finally, agriculture and mining, and services, demonstrate similar levels and dynamics in their NFA to capital ratios during the 1970-2007 period.

Overall, these results suggest that the rise of corporate net savings is characteristic of all industries.

Next we turn to firm-level characteristics and relate them to the rise in NFA. First, we study NFA for firms of different size, as measured by their employment level. Figure A3 reports the median NFA to capital ratio for different employment percentiles, separately for the 1970s and 2000s. It is easy to see that firms of all sizes were net borrowers in the 1970s. In the 2000s the relationship between the NFA to capital ratio and employment became clearly decreasing, with smaller and medium size firms turning into net creditors in that decade. At the same time, larger firms, while increasing their net savings a bit, have remained net debtors. A similar pattern applies at the industry level as well, especially for firms in manufacturing, services, and construction. The increase experienced by agricultural and mining firms, as well as the firms in trade, transportation and warehousing is characteristic of all firms in their respective industries, but is more muted.[65]



Source: Compustat

Figure A3: NFA to capital by firm size

Second, we study NFA to capital separately for entrants into Compustat and incumbents for each decade. Table A1 summarizes mean and median of NFA to capital for entrants and incumbents in the 1970s and 2000s. A firm is defined as an entrant in a given decade if it appeared in Compustat in any year of that decade.

Our results indicate that entrants tend to have higher NFA to capital ratios relative to incumbents, and that this tendency has become more pronounced over time.[66] The

---

[65] These results are available from the authors upon request.

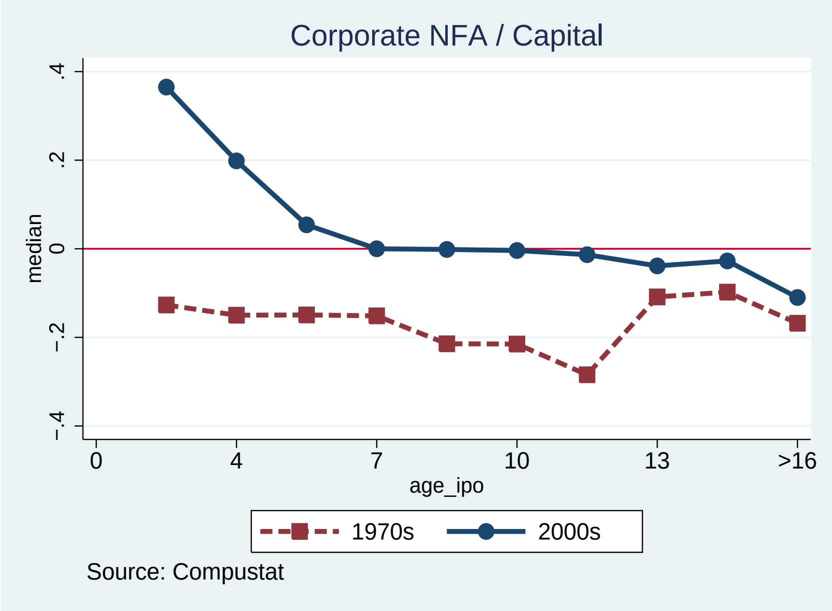
[66] Only in the 1970s is the median NFA to capital ratio for entrants somewhat below that for incumbents.

Table A1: NFA to capital: Entrants and incumbents

| | Entrants | | Incumbents | |
|---|---|---|---|---|
| | mean (i) | median (ii) | mean (iii) | median (iv) |
| 1970s | -0.12 | -0.19 | -0.13 | -0.16 |
| 2000s | 0.10 | -0.06 | 0.07 | -0.09 |

majority of the differential in NFA to capital ratios between incumbents and entrants is due to the larger cash holdings and short-term investments of the latter. Over time, both cohorts have increased their holdings of cash and short-term investments, but entrants have done so at a significantly faster pace.[67]

Are the differences between entrant and incumbent firms all due to their age differential, or is there an independent cohort effect? We use the number of years since the IPO as a measure of the firm's age. Figure A4 plots median NFA to capital as a function of age, separately for the 1970s and 2000s.



Source: Compustat

Figure A4: NFA to capital by firm age

The figure suggests no association between NFA to capital with age in the 1970s, but

---

[67] These results are available from the authors upon request.

the relationship turns negative in the 2000s. The fact that younger firms tend to save more relative to older firms in the 2000s is not surprising given our earlier finding of a negative association of the NFA to capital ratio with size, and the fact that age and size are positively correlated in our sample.

Finally, we investigate the role of all the factors discussed above jointly through a panel regression. In our benchmark specifications that pools firms in Compustat during the 1970-2007 period, we find that after accounting for employment and age, as well as industry and cohort fixed effects, NFA to capital has increased over time and significantly so.[68]

# B Model

## B.1 Feasible investment

We first focus on the set of feasible investment choices by a firm with net worth $\omega$ and state $\sigma$, $\Gamma(\omega, \sigma)$, for a given values for the borrowing constraint, $\alpha(\sigma)$. Given a choice for next period's capital stock, $k'$, there are enough resources to ensure non-negative consumption if and only if

$$\omega + p(k', \sigma) + \alpha(\sigma) \geq +k', \tag{A1}$$

that is, net worth, plus maximum equity issuance $s' = 1$ and maximum permissible debt $a' = -\alpha(\sigma)$, are sufficient to finance investment.[69] The set $\Gamma(\omega, \sigma) \subset \Re_+$ is thus all $k'$ such that (A1) is satisfied for given values of $\omega$ and $\sigma$.

To characterize the set, let

$$\psi(k', \sigma) \equiv p(k', \sigma) - k'.$$

---

[68] The time effect remains positive and significant for the 2000s when we include firm-level fixed effects in the panel regression. These results are available from the authors upon request.

[69] The present period's stock of capital, after depreciation, is included in the definition of net worth.

This is the maximum amount of equity funds available, net of next period's capital stock. It can possibly be negative if the firm is not able to raise enough equity to finance all investment. We can then re-write (A1) as

$$\omega + \psi(k', \sigma) \geq -\alpha. \tag{A2}$$

Function $\psi(k', \sigma)$ is not monotone in $k'$. It is easy to check that $\psi(0, \sigma) = 0$, $\psi(k', \sigma)$ is increasing at first with $k'$ and has a maximum at point $\tilde{k}(\sigma) > 0$ where

$$p_k\left(\tilde{k}(\sigma), \sigma\right) = 1.$$

Function $\psi(k', \sigma)$ decreases from then on, eventually crossing zero again. Thus we can characterize the set of feasible investments as

$$\Gamma(\omega, \sigma) = \left\{k' \geq 0 : \psi(k', \sigma) \geq -\alpha - \omega\right\}.$$

Thus the set $\Gamma(\omega, \sigma)$ is a closed interval, which guarantees that $\Gamma(w, \sigma)$ is convex and compact. However, for arbitrary choice of $\alpha(\sigma)$ and $\omega$, the set may be empty. In the next subsection, we show how to set the borrowing constraint to ensure that there is always a feasible level of investment–in other words, that the firm can satisfy debt payments and continue in operation.

## B.2 No default condition

We now derive the value of $\alpha(\sigma)$ that ensures there is no default with probability 1. This is equivalent to saying that at all times there is a feasible level of investment compatible with non-negative consumption—that is, given investment $k'$ and finance $e', a'$ choices, $\Gamma(\omega', \sigma')$ is not empty. The calculation is greatly simplified given our productivity process.

Clearly $\Gamma(\omega_1, \sigma) \subseteq \Gamma(\omega_2, \sigma)$ if $\omega_1 < \omega_2$, with strict sign if $\Gamma(\omega_2, \sigma) \neq \emptyset$. In the event of an operational loss, $\sigma_0$, the firm's net worth is given by $\omega'(\sigma_0) = Ra'$. It is straightforward to check that next period's net worth is the lowest whenever the firm suffers an operational loss shock, $\omega'(\sigma_0) \leq \omega'(\sigma')$, and thus $\Gamma(\omega'(\sigma_0), \sigma_0) \subseteq \Gamma(\omega'(\sigma'), \sigma')$. Since there is a strictly positive probability to transition to operational losses from any state, we only need to ensure that $\Gamma(\omega'(\sigma_0), \sigma_0)$ is non-empty.

Let $\bar{\psi} \equiv \max_{k' \geq 0} \psi(k', \sigma_0)$. Feasible set $\Gamma(\omega, \sigma_0)$ is not empty if $\bar{\psi} + \alpha(\sigma_0) \geq -\omega$, that is, the firm is able to raise enough equity and debt, net of investment, to finance its net worth position. Since $\omega'(\sigma_0) = Ra'$, we obtain that

$$Ra' \geq -\alpha(\sigma_0) - \bar{\psi}.$$

Note that the preceding state $\sigma$, the investment level and equity issuance, $k'$ and $e'$, are irrelevant. Thus a single borrowing constraint $\alpha = \alpha(\sigma)$ is sufficient and necessary to ensure no default. Substituting, we obtain

$$\alpha = \frac{\bar{\psi}}{R - 1}.$$

It is, of course, possible to set the borrowing constraint at arbitrary values lower than $\alpha$ and there would be no default with probability 1.

## B.3 Taxes and equity markdown

We provide here the derivation of the fiscal cost of equity accounting for dividend, capital gains, and interest income taxes as well as additional considerations as inflation or asset growth that determine the tax liabilities of both households and firms. As in Section 3, the household optimality equations imply that the after-tax returns of equity and debt are equated. From these we derive the equilibrium pre-tax returns and compute the wedge in financing costs that the firm faces.

Let us start with the household problem. The first-order necessary condition associated with the decision to hold corporate debt is:

$$u_t^c = \beta u_{t+1}^c \frac{1+(1-\tau^i)\tilde{R}}{1+\gamma_p}$$

where $\gamma_p$ is the growth rate of the nominal price level. The corresponding optimality condition to equity holdings is

$$P_t u_t^c = \beta u_{t+1}^c \frac{(1-\tau^d)D_{t+1} + P_{t+1} - \tau^g(P_{t+1} - P_t)}{1+\gamma_p}$$

where we decomposed equity payouts into capital gains and dividends.[70] We also assume, for simplicity, that accrued, rather than realized, capital gains are taxed. Let $d$ and $p$ be the dividend and asset price, in real terms. Combining the above expressions we obtain the arbitrage condition between debt and equity:

$$\frac{1+(1-\tau^i)\tilde{R}}{1+\gamma_p} = (1-\tau^d)\frac{d_{t+1}}{p_t} + \frac{1+\gamma_a(1-\tau^g)}{1+\gamma_p}.$$

The left-hand side is the after-tax return on debt; the right-hand side is the after-tax return on equity. Thus the equity price in equilibrium must satisfy

$$p = \frac{(1-\tau^d)d}{\frac{1-\tau^i}{1+\gamma_p}\tilde{R} - (1-\tau^g)\frac{\gamma_a}{1+\gamma_p}} \tag{A3}$$

where we dropped time subscripts assuming a constant dividend-to-price ratio. This is the equity price that the household will demand from the firm to remain indifferent between investing in debt or equity. For the equity price to be positive, it must be that $(1-\tau^i)\tilde{R} - (1-\tau^g)\gamma_a > 0$. Otherwise the asset price appreciation would, by itself, pay a higher return than debt.

Next we derive the cost of debt and equity for the firm. The cost of debt, per dollar

---

[70] We need to specify the equity distributions in order to correctly compute their effective tax, as dividend income and capital-gains have been historically taxed at different rates.

borrowed, is

$$1 + r = \frac{1 + (1 - \tau^c)\tilde{R}}{1 + \gamma_p},$$

where we have taken in account that interest payments are deducted from the corporate-tax liabilities. Each dollar raised from equity must be repaid at rate $(D_{t+1} + P_{t+1})/P_t$ or, in real terms,

$$\rho^e = \frac{d}{p} + \frac{1 + \gamma_a}{1 + \gamma_p}.$$

The markdown $\xi$ is the relative cost of debt to equity for the firm, that is, $1 + r = \xi \rho^e$. If $\xi < 1$, debtors demand a lower rate than shareholders, and we say debt has a fiscal advantage. Substituting the formulas for $1 + r$ and $\rho^e$, as well as the equity price derived in A3, we obtain

$$\xi = \frac{(1 - \tau^d)\left((1 - \tau^c)\tilde{R} - \gamma_a\right)}{(1 - \tau^i)\tilde{R} - (1 - \tau^g)\gamma_a}.$$

Note the dividend $d$ cancels, so the markdown is independent of the unit of account of the shares. While the inflation rate does not enter the expression explicitly either, $\tilde{R}$ is the nominal interest rate and thus the relative cost of equity will vary with the level of expected inflation.

# C A simple example

We present a simple example based on our model to illustrate the key intuition in the paper, namely, that firms issue equity—despite its higher cost relative to debt—in order to avoid having to issue more equity in future periods. The example contains the key elements from the model: debt subject to a borrowing constraint, state-contingent equity payouts, a shock, and a markdown on the equity price that results in shareholders demanding a higher expected return than debtors. The dynamic nature of the financing decision also requires a multi-period setup. We are able to encompass all these considerations and keep the example transparent only in a very simplified setting, where we attempt to illustrate the trade-off between equity and debt, as well as a sufficient condition for the use of costly equity. For completeness we solve for the optimal mix of debt and equity numerically.

As we describe the example below we attempt to preview the role of each assumption, discussing the relationship with the model in the main text.

## Environment

Timing is as follows. At period $t = 0$ the firm must make the key financing decision between debt and equity in order to finance an initial project which has a stochastic return. For periods $t = 1, \ldots, T$ the firm invests in a safe project that requires additional investment which, in turn, demands the firm rolls over or expands its financing. Finally, in the last period $t = T + 1$ the firm liquidates, which allows us to keep the example within a finite horizon.

### Projects

There are two projects or investment opportunities. Project $A$ is available at date $t = 0$ and project $B$ is available at dates $t = 1, ..., T$.

Project $A$ requires one unit of capital at date $t = 0$. At date $t = 1$ the project pays $y_A > 0$ with probability $\pi$, 0 with probability $1 - \pi$. This is the sole source of uncertainty in the example. Project $A$ does not pay anything at all other dates $t < T + 1$. At date $t = T + 1$ it pays 1 with probability one. The latter assumption simplifies the liquidation period $T + 1$ and backs up the specification of the borrowing constraint at date $t = 0$.

Project $B$ requires one unit of new capital at *every* date $t = 1, \ldots, T$ and pays $y_B > 0$ at dates $t = 2, \ldots, T + 1$ with probability one.

For simplicity, capital fully depreciates every period.

### Entrepreneur

The entrepreneur is risk neutral and does not discount between periods. We also assume it has no net worth at date $t = 0$ so it must seek external finance.

### Finance

In each date $t$, there are two options for the entrepreneur to finance her needs:

- **Debt.** Debt must be paid in all states of the world. Consistent with the no-discount assumption, we assume a zero interest rate, $R = 1$. There is a borrowing constraint, set at 1 at all periods.
- **Equity.** Equity is a state-contingent claim, which pays the shareholder 1 if the project delivers a positive return in the next period, zero otherwise. Investors demand price $p_t$ at dates $t = 0, \ldots, T$ for each unit of equity.

### Equity prices

The actuarially-fair prices for equity would be $p_0^f = \pi$ and $p_t^f = 1$ for all $t > 0$, recalling that projects are completely safe starting in period 2. These prices would satisfy the no-arbitrage conditions for a risk-neutral investor, equating the expected return of debt and equity, i.e., $\pi/p_0^f = R = 1$ and $1/p_t^f = R = 1$ for $t > 0$.

As in the paper, we assume equity financing is more expensive than debt: equity prices are not actuarially fair. There is instead a markdown on the equity price, $\xi < 1$, in both periods. Equity prices are thus $p_0 = \xi p_0^f$ and $p_t = \xi p_t^f$. The markdown on the price implies that investors demand a *higher* expected return on equity than on debt, i.e.,

$$\pi \frac{1}{p_0} = \frac{1}{\xi} > 1 = R,$$

and

$$\frac{1}{p_t} = \frac{1}{\xi} > 1 = R$$

for all $t > 0$. Note that equity prices are different at dates $t = 0$ and $t > 0$, but equity delivers the same expected return in all periods, $1/\xi$.

### Project returns

The projects' payoffs are as follows:

- Project $A$ has a high return, so it can be fully financed by equity:

  $$y_A > \frac{1}{p_0}.$$

  By the assumption $\xi < 1$, it implies that $\pi y_A > 1$, so it also delivers a positive expected return if financed by debt.

- Project $B$ has a positive, but low return. We pick the payoff of project $B$ to be

  $$y_B = \frac{1}{\xi}.$$

  This implies that project $B$ delivers (1) a zero net return if financed exclusively with equity, and (2) a strictly positive return if financed to some extent by debt.

The exact choice of $y_B$ is not necessary for the mechanism to operate, but simplifies greatly the solution. For example, if $\frac{1}{\xi} > y_B > 1$ it is then possible that the firm prefers not to invest in project $B$, but otherwise the payoffs and decisions are identical. The payoff of project $B$ can also deliver a positive return if financed exclusively with equity, $y_B > \frac{1}{\xi}$, and our mechanism remain relevant, though in this case there are no analytic solutions.

## Finance decision

Let us now compare the expected payoff of financing the project $A$ (1) exclusively with debt and (2) exclusively with equity. As will be clear below, the financing decision at date $t = 0$ ties down the investment and financing decisions from that point onward. Neither "corner" solution is typically optimal, yet they illustrate the trade-off between debt and equity as well as provide a sufficient condition such that the all-debt choice is not optimal—i.e., the optimal financing will feature at least some equity issuance.

Let $D(\xi; T)$ denote the expected payoff when using debt exclusively at date $t = 0$, and $S(\xi; T)$ the expected payoff when using equity exclusively at date $t = 0$. The explicit dependence on $\xi, T$ will be explained below.

### Debt-only at date $t = 0$

Assume that the firm finances the project $A$ at date $t = 0$ with one unit of debt.

If the project delivers a positive return at date $t = 1$, the firm can repay the initial set of debtors since $y_A > R = 1$. Then the firm can finance project $B$ with debt in all periods $t = 1, \ldots, T$, simply repaying debtors and re-issuing one unit of debt in each period.[71] The total payoff in this case is

$$y_A + T(y_B - 1).$$

(Recall that at date $T + 1$ the firm gets $y_B + 1$ for sure and pays 1 back).

If the project delivers a zero return at date $t = 0$, the firm needs to finance (1) the payment due to the debtors, 1, and (2) the new unit of capital needed for project $B$. Debtors gladly roll over the debt, knowing that eventually at date $T + 1$ project $A$ will deliver 1 and the firm will be able to pay debt back. However, the borrowing constraint prevents the firm from issuing any additional debt.

---

[71] Since there is no payoff uncertainty going forward, using debt to finance is strictly preferred to equity at this stage simply by virtue of its lower cost.

Instead the firm must rely on equity, at price $p_1$, to finance project $B$, i.e., the firm needs to issue $1/p_1$ units of equity. By assumption, doing so delivers zero net return to the firm since $y_B = 1/p_1$. Say the firm anyway undertakes the project. At date $t = 2$, the situation is identical: the return of project $B$ is used to pay back shareholders, the firm has to continue to roll over existing debt, and it can only continue to finance project $B$ with new equity. Finally at date $T + 1$ debtors get paid with the last-period payoff of project $A$. The total payoff in this state of the world is actually 0.[72]

In expectation, we obtain

$$D(\xi; T) = D(T) = \pi \left( y_A + T(y_B - 1) \right). \tag{A4}$$

Note that the example has been constructed such that, if project $A$ fails after being financed exclusively with debt, the firm finds itself stuck at the borrowing constraint at dates $t = 1, \ldots, T + 1$. Being unable to issue further debt is costly because the cost of equity wipes out the return from project $B$. In the main model the situation is not as stark, as positive shocks can lift the firm from the borrowing constraint early, though the possibility of negative shocks also implies that the borrowing constraint is costly even if the firm is not yet fully maxed out on debt.

### Equity-only at date $t = 0$

Assume that the firm finances the project at date $t = 0$ exclusively with equity at price $p_0$. It thus needs $1/p_0$ units of equity.

If the project delivers a positive return in $t = 1$, the firm pays back the investors and switches to debt for financing project $B$—it is clearly cheaper to rely on debt from period $t$ onward since there is no uncertainty about future payoffs at this stage. The total payoff

---

[72] If $y_B < 1/p_1$ the firm would strictly prefer not to invest in project $B$, leaving the payoff calculations unchanged.

in this state of the world is

$$y_A + 1 + T(y_B - 1) - \frac{1}{\xi\pi}.$$

If the projects delivers a zero return in $t = 1$, the firm is off the hook regarding equity payouts. It has no debt, and thus it can finance the investment in project $B$ with debt without violating the borrowing constraint. This is the precise sense in which having issued equity at date $t = 0$ allows the firm to *avoid* using equity at date $t = 1$, saving on financing costs from $t = 1$ to $T$ by issuing *debt* instead. The total payoff in this state of the word is then $T(y_B - 1) + 1$.

In expectation, we obtain

$$S(\xi; T) = \pi(y_A - \frac{1}{\xi\pi}) + T(y_B - 1) + 1 = \pi y_A + T(y_B - 1) - (\frac{1-\xi}{\xi}). \tag{A5}$$

## Sufficient condition for using costly equity

Let us now compare the payoffs of each strategy $S(\xi; T), D(T)$. We will provide a simple condition such that $S(\xi; T) > D(T)$ which shows that the all-debt strategy is not optimal: hence some equity financing is optimal even if equity is costly relative to debt.

Re-arranging terms, the condition for equity usage, $S(\xi; T) > D(T)$, becomes

$$(1 - \pi)T(y_B - 1) \geq \frac{1}{\xi} - 1. \tag{A6}$$

The left-hand side of (A6) is the benefit of equity, which allows the firm to reap the benefits from project $B$ *by issuing debt* in case project $A$ fails. Thus it is weighted by the probability of failure of project $A$, $1 - \pi$. The right-hand side of the condition is the cost of equity, the excess return demanded by shareholders over debts (note it would be zero if $\xi = 1$). The firm incurs this extra cost with probability one. Comparing the terms for $S(\xi; T)$ and $D(T)$ we can also see that financing decisions do not impact the expected gross return from project $A$, $\pi y_A$, and thus these terms are absent from (A6).

Using the value for $y_B$, it is quite easy to show that (A6) is satisfied whenever

$$T \geq \frac{1}{1-\pi}.$$

This makes clear that the multi-period structure of the example is indispensable: The immediate interpretation of $T$ is the time the firm will spend stuck at the borrowing constraint if relying on debt initially. Or, in other words, the benefits of using equity initially, and then being able to reap the benefits of project $B$, accrue to all periods $t = 1, \ldots, T$. It is easy to show that if project $B$ had no net return with debt financing, $y_B = 1$, then using equity is never optimal since there is no cost associated with being at the borrowing constraint. For intermediate cases $y_B \in (1, 1/\xi)$, there exists a finite $T^*(\xi)$ such that for all $T \geq T^*(\xi)$, condition (A6) is satisfied.

The rest of the model's elements that we labeled as essential in the main model also prove to be so in the simple example:

- If there was no borrowing constraint, then the firm would be able to rely exclusively on debt in all states of the world, and no equity would be issued.
- Similarly, equity would not be optimal if shareholders demanded the same payment in all states of the world, or the correlation with the project return would be negative.
- If equity was not costly, then the debt-equity mix would be indeterminate. Perhaps more interestingly, if equity was costly *only in the first period*, then there would be no cost associated with a binding borrowing constraint, and no equity would be issued.

The key difference with the full model is that the time spent at the borrowing constraint is stochastic, rather than deterministic as in this simple example. Specifically, the firm may get lucky and have a positive shock, allowing it to exit the borrowing constraint quickly and with little cost. Or it can receive further negative shocks and stay at the constraint for an undetermined amount of time, since the main model is infinite horizon. Shocks also imply that the borrowing constraint impacts financing and investment decisions even if the firm has some net worth.[73]

## Optimal finance decision

Condition (A6) is sufficient, but by no means necessary, for using costly equity. Typically the firm will prefer an interior solution, combining debt and equity. Unfortunately, there is no analytic solution to the optimal mix of debt and equity at date $t = 0$.

Consider a firm that uses mainly debt at date $t = 0$ and a small amount of equity, say $\delta$. If project $A$ delivers a positive return, the firm incurs a slightly higher expected cost of financing as it has to repay its shareholders,

$$\delta \left( \frac{1}{\xi} - 1 \right).$$

What happens if projects $A$ fails? The firm now has a bit of debt capacity, $\delta$, which is provided by the initial equity issuance (the initial debt, $1 - \delta$, needs to be rolled over). This allows the firm to issue $\delta$ debt at $t = 1$ to assist the financing of project $B$—the rest, $1 - \delta$, will require equity. At date $t = 2$ the firm finds that the return to project $B$ is not fully captured by shareholders,

$$y_B - \delta R - \frac{1 - \delta}{p_1} = \delta \left( y_B - 1 \right).$$

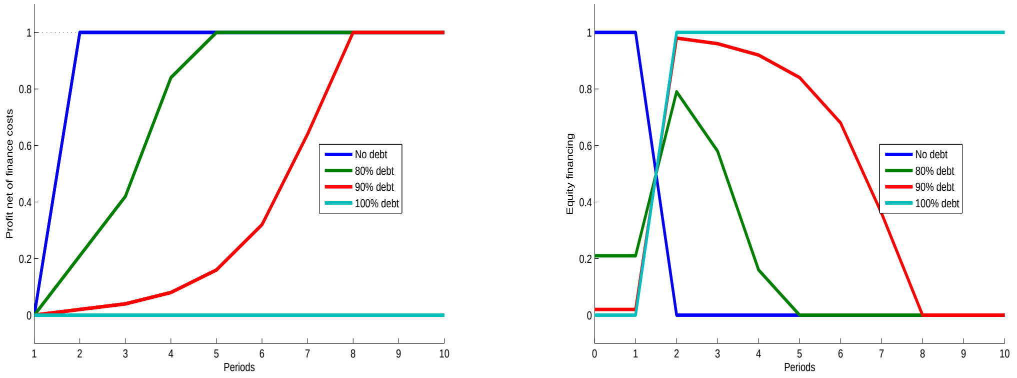
The firm can then use the additional funds $\delta \left( y_B - 1 \right)$ to finance project $B$ at date $t = 2$, further reducing the need for equity at $t = 2$, which in turn increases the fraction of project $B$ return that it can capture, and so on.

Figure A5 provides a brief illustration of the dynamics discussed above. Panel (a) plots the return from Project $B$, net of finance costs, in the event that in period $t = 1$ project

---

[73] The simple example also does not feature the precautionary-savings channel, since all uncertainty is resolved at date $t = 1$ for simplicity.

$A$ delivered nothing, for four mixes of debt-equity at date $t = 0$. The characterization above corresponds to the dark blue and cyan lines for all-equity and all-debt, respectively. Two intermediate cases of 80% and 90% debt financing are displayed. The more debt the firm initially had, the longer it takes it to recapture the cash flow from project $B$ from shareholders. The second panel of Figure A5 displays the share of equity financing over time for the same initial mixes of debt and equity at date $t = 0$. Again, only the dynamics corresponding to the event that project $A$ failed to deliver a return are presented. The plot makes it clear that issuing equity initially allows the firm to save on equity issuance later on, over several periods, and thus save on overall financing costs.



(a) Profit net of finance costs

(b) Share of equity financing

Figure A5: Dynamics of cash-flow and equity: Various debt levels at $t = 0$

Figure A6 conducts a numerical search for the optimal mix of debt and equity, that is, the one that maximizes the expected net value at date $t = 0$. The benefits of equity, displayed in the Figure A5, are balanced against the additional cost of equity. For the choice of numerical values here the optimal mix is somewhere south of 80% debt.

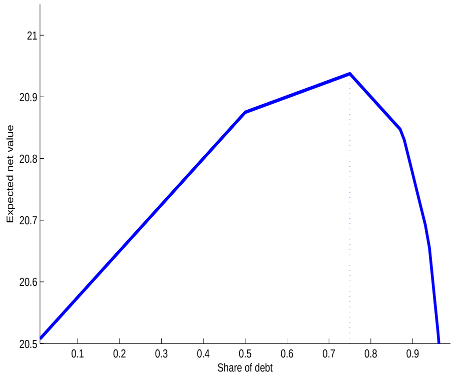


Figure A6: Optimal mix of debt and equity

# D Calibration

## D.1 Tax rates in the 1970s

We document here briefly the model simulations under estimates for effective tax rates in the 1970s. Let us start with corporate tax rates, that were definitively higher in the 1970s than in the 2000s, with the top statutory rates being 46-48 percent until the mid-1980s. Estimates of the effective tax rate on corporate profits for that period tend to be somewhat lower, but above 40 percent. For our exercise below, we set the corporate tax rate at $\tau^c = .46$. The calibration for the 2000s had set the corporate tax rate at 34%.[74]

There were also some differences in how capital-gains income were taxed in the 1970s and 2000s. For the 1970s capital gains were taxed at ordinary income rates, though a system of minimum rates combined with exclusions complicate the picture.[75] At the end we use the statutory rate predominant in the 1970s, at 25% according to Poterba (2004)—the same source we used for the 2000s.

Before we turn to the results, we note that we encountered one difficulty when changing the corporate tax rate: For the model's steady state to be well defined, entrepreneurs and

---

[74] See Gravelle (2004), Randolph (2005), and Slemrod (2004) for several estimates of the effective corporate tax rate across time.

[75] See Auten (1999) for a brief overview.

the rest of the households must share the same *after-tax* real interest rate. The condition, in terms of the notation in the paper, is

$$\beta(1-\tau_i) = \beta_e(1-\chi)(1-\tau_c).$$

If the above condition is violated either households or entrepreneurs—depending on the sign of the inequality—will embark on ever-decreasing path of consumption. We thus need to adjust the intertemporal discount factor $\beta$—the inverse of the pre-tax real interest rate—when we change the corporate tax rate to equate the after-tax real rates.[76] Admittedly this is less than ideal, and it would not be necessary in some other models, e.g., with finitely-lived households. However, such extensions are beyond the scope of the paper.

Table A2 collects all the results. The first column contains the data for the 1970s, including the effective tax rates. We then report the results from five simulations in the model. Simulation (1) uses the tax rates from the 2000s and is included for reference. Simulations (2) to (4) adjust one tax rate at a time (simulation (4) are the results reported in Section 7). Finally the last simulation (5) includes all the effective tax rates in the 1970s. All other parameters in the simulation are kept constant, with the noted exception of the intertemporal discount factor in simulations (3) and (5).

Let us start by discussing simulation (2) where only the capital-gains tax rate is changed. As claimed in the main text, the capital-gains tax rate has a small effect, barely budging the numbers. The simple reason is that the equity markdown barely changes with the capital-gains tax, being just a small component of the fiscal burden of equity.

The impact of the higher corporate tax rate (3) is more marked according to the model. The higher corporate tax rate does increase the relative fiscal burden of equity relative to debt, and thus can explain some of the shift in NFA positions: The average NFA/K turns into negative territory and the fraction of firms with positive NFA drops, albeit the

---

[76] If we change $\beta_e$ instead we would neutralize the effect of the corporate tax rate on the fiscal burden of equity.

Table A2: Other tax rates in 1970s

| | Data | Model | | | | |
|---|---|---|---|---|---|---|
| | | (1) | (2) | (3) | (4) | (5) |
| *Effective tax rates* | | | | | | |
| Dividends | .28 | .15 | .15 | .15 | **.28** | **.28** |
| Corporate | .46 | .34 | .34 | **.46** | .34 | **.46** |
| Capital gains | .25 | .15 | **.25** | .15 | .15 | **.25** |
| | | | | | | |
| *NFA/K* | | | | | | |
| mean | -0.12 | 0.06 | 0.05 | -0.01 | -0.06 | -0.08 |
| median | -0.17 | -0.07 | -0.07 | -0.05 | -0.16 | -0.15 |
| Pr($NFA > 0$) | 26.9% | 41.8% | 41.2% | 40.5% | 32.3% | 32.7% |
| std dev | 0.39 | 0.67 | 0.66 | 0.59 | 0.59 | 0.61 |
| 10pct | -0.50 | -0.51 | -0.50 | -0.51 | -0.52 | -0.51 |
| 25pct | -0.34 | -0.39 | -0.38 | -0.39 | -0.44 | -0.46 |
| 75pct | 0.02 | 0.23 | 0.21 | 0.10 | 0.07 | 0.05 |
| 90pct | 0.29 | 1.65 | 1.61 | 1.1 | 1.00 | 1.05 |

latter effect is quite small. We also see some additional effects. The distribution of NFA across firms gets somewhat compressed, and as a result the median NFA/K ratio actually increases. The standard deviation and the percentiles also show that the distribution is a bit less dispersed.

We should note that the change in the corporate tax rate has some additional effects beyond its impact on the fiscal burden of equity. First, a higher corporate tax rate mechanically reduces the volatility of after-tax cash flows, which feeds into the precautionary motive associated with NFA accumulation. Second, it changes the desired capital to output ratio since depreciation is expensed from corporate tax liabilities. Third, unfortunately the necessary adjustment in the intertemporal discount rate also impacts the capital-output ratio and dampens somewhat the increase in the fiscal burden of equity.[77] These effects vary in magnitude depending on the net worth level of the firm.

Finally, we compare simulation (4)—the reported results in Section 7—with simulation

---

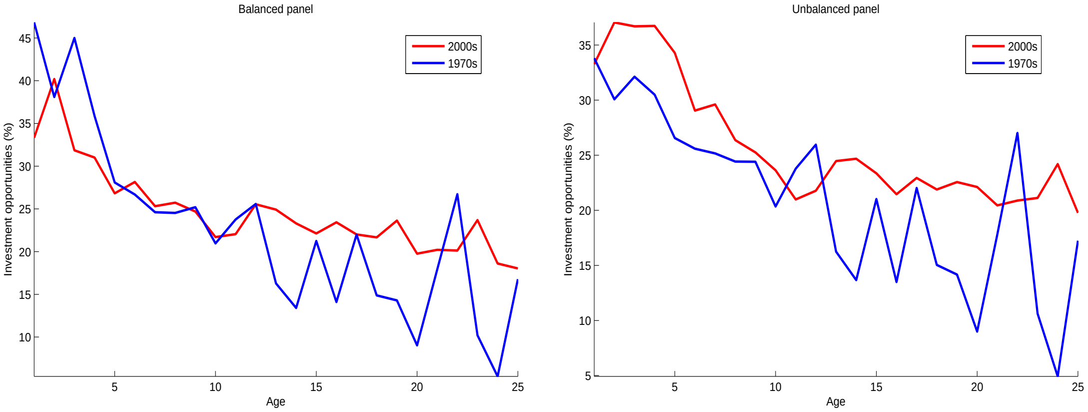
[77] The after-tax real rate for households decreases by about 75 basis points, with $\beta = .967$ compared to $\beta = 0.96$ in the baseline calibration.

(5) including all effective tax rates in the 1970s. The differences are small, reducing a bit the gap between predicted and observed average NFA/K ratio, but increasing the gap with the median. Overall, the effect of the higher corporate tax rate is more muted once the higher dividend tax rate is taken into account: As firms are already quite leveraged, a further reduction in the fiscal burden of equity has a smaller impact. That said, the additional effects of the higher corporate tax rate and the needed adjustment in the intertemporal discount rate have some impact on the overall distribution.

## D.2 Firm volatility in the 1970s: Investment opportunities

We document how the profile for investment opportunities—compares between the 1970s and the 2000s. Unfortunately, the level of detail regarding investment expenditures in the data is lower in the 1970s than in the 2000s. To circumvent this, we used the change in capital stock (using an extended definition that includes property, plants, equipment, inventories, intangibles, other) and compared it with operating income after depreciation since this new measure of investment excludes depreciation expenses.

We did not find systematic differences in the profile for investment opportunities. Figure 3 compares the probability of an investment opportunity by age, both for the 2000s and 1970s, and again for the balanced panel (left plot) and the unbalanced panel (right plot). The profiles are roughly comparable, with perhaps the only remarkable difference being a slightly lower frequency of investment opportunities past the first 15 years in the 1970s.



(a) Balanced panel (b) Unbalanced panel

Figure A7: Investment opportunities by age: 1970s and 2000s